# STRATEGIC PLAN - NEWFOUNDLAND AND LABRADOR AQUACULTURE

*Prepared By:*

**Burke Consulting Inc.**
**Manuels, NF**

*In Collaboration With:*

**Resource Development Associates**
**St. John's, NF**

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## EXECUTIVE SUMMARY

In 1999, the Newfoundland Aquaculture Industries Association, with the Department of Fisheries and Aquaculture, the Department of Fisheries and Oceans, the Atlantic Canada Opportunities Agency, Human Resources Development Canada and the Department of Development and Rural Renewal, agreed that an industry-wide strategic plan was needed for the Newfoundland aquaculture industry. Burke Consulting Inc. was contracted to undertake this planning exercise. In collaboration with Resource Development Associates, the company assembled a team of specialists in the area, and developed a strategic plan through a review of the available data, extensive interviews, and SWOT analyses and evaluations of a group of 13 species of cold-water finfish and shellfish. The strategy includes recommendations on how to proceed with each of the 13 species considered, as well as recommendations to address general industry concerns that became apparent over the course of the review.

### Industry-wide Concerns

In the course of this review, it became evident that there were several issues that affected the industry as a whole. They included the following:

- The need to focus on developing a success story or stories, rather than spreading and diluting efforts over a wide range of species;
- A need to create confidence in the industry and to provide a basis for attracting investment, both private and public, into the industry;
- The need for an industry-wide comprehensive cost reduction strategy;
- The need for long-term market development;
- The need to deal with the debt loads and lack of equity that burden the industry;
- The need to source strategic investments to provide private investment capital necessary to develop the industry;
- The need to improve the regulatory environment and reduce conflict;
- The need for human resource development to strengthen business and leadership skills and biological and technical expertise in the industry;
- A need for extension services and research and development to ensure the development of new species and the ongoing reduction of costs and improvement of efficiencies;
- The need for the continuation of the industry's association, NAIA, to represent the industry and give it a strong voice.

The strategy discusses each of these concerns individually and a series of recommendations is presented to address them. The strategy recognizes that there are four species which offer the best opportunity for success in the short term. These are Atlantic salmon, steelhead trout, mussels, and Atlantic cod. It is stressed that commercial public sector support should be targeted primarily at those four species. Other general recommendations include the establishment of a working group to oversee the implementation, at an industry level, of various cost reduction measures; industry support for marketing alliances and joint ventures; encouragement of product diversification and other measures for long-term market development; and implementation of measures to push the industry beyond the financial situation it finds itself in. Continued improvements to the regulatory environment are stressed and the importance of maintaining government support for a strong industry voice, in the Newfoundland Aquaculture Industries Association, is highlighted. Recommendations on ways to safeguard and enhance training, extension services and research and development for the industry are made as well.

**Species Review**

The viability of culturing each of 13 cold-water species is examined. The 13 species chosen are either currently farmed, under development or are being considered for development in Newfoundland. They include three commercial species: Atlantic salmon, steelhead trout and mussels; six species that are considered developmental: Atlantic cod, giant scallops, Arctic charr, American eels, yellowtail flounder and sea urchins; and five species that are still being researched: Atlantic halibut, wolffish, witch flounder, soft shell clams and seaweed (kelp).

*Atlantic salmon / Steelhead trout.*

Until recently, the outlook for this industry had been less than promising. In the late 1990s, however, the industry began taking steps to improve its performance. As a result, the outlook for salmon and steelhead trout farming is much improved. The consultants recommend that salmonid aquaculture continue to be considered a high priority for commercial development in the province. In particular, steelhead trout should be accorded top strategic priority because environmental conditions are better suited to this species and market opportunities may be superior for the trout.

Because of the high level of debt that has resulted from the industry's past history, it is recommended that investment prospecting be undertaken. This will allow for further growth, which is necessary if the industry is to compete in world markets. Investment prospectors should seek out investors who are able to contribute management and leadership skills, as well as marketing and operations experience. The need to reduce costs and increase economies of scale and collaboration is recognized, and it is recommended that the public sector support industry attempts to achieve these improvements. Training is identified as a critical component in the success of the industry and recommendations to deliver the training effectively are offered. Industry is encouraged to lead efforts to increase hatchery capacity and improve or expand processing capabilities.

*Mussels*

Analysis revealed good potential for long-term profitable growth in rural-based commercial mussel culture if strong managerial, marketing and technical expertise is in place to support it. While the sector's past history indicates poor financial performance, steps are being taken to improve viability by a small group of full-time farmers. Newfoundland's potential for growth exceeds that of the other Atlantic provinces. It is felt that Newfoundland can develop into a significant player in the North American market. The development of secondary production (already under way) will reduce the competitive disadvantages that are experienced in fresh production.

It is recommended that the mussel culture sector be considered a high priority for continued development. It is further recommended that, since the mussel industry is burdened with high debt loads and low cash reserves, investment prospecting be undertaken and the public sector examine ways of alleviating the debt in this sector. Government is urged to continue and enhance the Mussel Incentive Program. Other recommended measures include a comprehensive cost reduction strategy, measures to develop economies of scale, a quality assurance program, the development of secondary processing efforts to reduce transportation costs, possible regionalisation of processing capacity, and continued work to improve the regulatory environment. The need for extension services and training is highlighted.

*Atlantic cod*

Atlantic cod is viewed as having the best potential of the remaining species to develop commercially, and the consultants recommend it be given priority for development. Seasonal cod growout is an expanding, profitable sector which has the potential for further growth, even though it faces limitations primarily in sourcing wild seed stock and addressing wild feed issues. Cod aquaculture from the egg to market is still in the research and development stage. However, positive market developments, significant biological experience and advances, and a strong commitment from the private sector are in place. These factors increase cod aquaculture development's priority standing among the developmental species.

It is recommended that Atlantic cod aquaculture be accorded medium- to high-priority for commercial development. Growout of cod is in pre-commercial stages, and warrants support to develop it further. The list of recommendations for the sector is topped by cost-reduction strategies and market initiatives to enhance the sector's profitability. Initiatives to expand seasonal growout are recommended as well as training measures and ways to maintain a high level of quality. Full-scale aquaculture is still in research and development but its prospects are considered very good. It is recommended that further research and development be supported. The consultants believe that industry initiatives to develop a hatchery and nursery/growout operations should be supported by government, conditional upon evidence of competent management, technical expertise and private sector financing and commitment.

*Giant scallops*

A review of the scallop industry worldwide showed that market conditions were strong for scallop meats, owing in part to wild resource shortages and strong economic conditions. Many have attempted the culture of the species in Atlantic Canada over the past ten years. While the shellfish is suited naturally to the marine environment, the species has defied viable large-scale commercial development in the region. In Newfoundland, considerable amounts of public funding, R&D efforts and private attempts to establish growout operations have not been successful in developing the industry, which is now marked by declining production. In 1998, only one tonne of product was recorded. The hatchery, which was opened in 1995, has not yet reached routine production and new investment in farms is not planned by the existing private sector players.

It is recommended that the sector be given a low priority for commercial development at this time; public funding for commercialization is not warranted. Future support for development should be considered only in response to a solid private proposal backed by a strong business plan and only if the basic obstacles to development have been overcome.

*Arctic charr*

In Newfoundland, considerable public funding has been invested in the development of this species over the past 15 years. Still, Arctic charr has not developed into a commercially viable culture species. Many challenges will take several years to work out. The potential may exist through collaboration with others to develop the culture of charr, but it will be a very expensive initiative. Any future development should be led by the private sector and should be backed by a strong, sound business plan and solid corporate track record.

The species is considered a low priority for commercial development and it is not seen to warrant public investment for commercialization. Further development should be re-considered, only if there is strong private sector backing and a sound business plan, and if the basic obstacles to development have been overcome.

*American eels*
Eel aquaculture is in its infancy in Newfoundland, where a private concern recently began ongrowing eels purchased from fishermen. The company plans further development by obtaining a turn-key operation from a Danish company.

Access to a secure and proven source of elvers as well as biological and technical resources and the ability to lower operating costs through a new recirculating technology will be critical to success. Because of the size of investment required to establish such an operation, there will be little room for mistakes. Prospective eel farmers will have to have strengths in managerial, technical and financial areas to succeed.

American eel culture has a reasonable chance to develop commercially. Research may be required to address outstanding issues in its culture but, for the most part, the technology and methods are well known and available from Europe. Public sector assistance should be given for development only if the private sector proponent can supply adequate resources to the initiative, is skilled in management and marketing, and can prove a steady source of elvers for the enterprise.

*Yellowtail flounder*
The yellowtail flounder is not a species produced in commercial aquaculture. During the 1990s, when a moratorium had been placed on the wild fishery for this species research was started on the biological requirements of the species. Since then, trials have uncovered a number of biological factors in its growth which throw into question the economic viability of the species' aquaculture.

It is recommended that the species be accorded a low priority for development in Newfoundland. In addition to the questionable economic potential that the species has, it will require a high capital investment to generate only a small number of jobs, the private sector partner in the research has not expressed future commitment to the project, and yellowtail flounder is not a premium market species. It is concluded that commercial development of this species does not warrant support from public funds at this time.

*Sea Urchins*
The good market for sea urchin roe in Japan, coupled with wild resource shortages, has created interest in the aquaculture of sea urchins. To date, research on producing roe of acceptable quality to the Japanese market has followed two routes: ways to ranch mature wild sea urchins to improve their roe yield and/or quality, and ways to grow the species in full-aquaculture systems from egg to market size. In Newfoundland, research has been under way on ongrowing for a number of years and has produced results in a number of areas. Commercial viability of ongrowing urchins, however, has not yet been determined. In full-scale aquaculture, small-scale work is proceeding at the Marine Institute on a number of issues and research in other areas is being followed.

It is recommended that sea urchin aquaculture not be considered a high priority for commercial development at this time, although potential may exist for future development based on addressing outstanding issues. Roe enhancement, especially through bottom culture, appears to offer favourable potential and it is felt that government should consider support on a case-by-case basis. Assistance on sea urchin aquaculture research and development should be focussed on addressing outstanding issues with respect to feed development and economic potential. Collaborative initiatives led by current private sector players should be given priority.

*Atlantic halibut*

After review of the culture of halibut, it is felt that its development in Newfoundland poses very high risks, and the economics have not been proven. Although significant opportunities exist in the premium white flesh fish market, the development of a commercial halibut culture industry could lower prices, even at a low level of production. Given these factors, Atlantic halibut should not be considered as a high priority for current commercial development. Public sector commercial funding agencies should only consider assistance if private sector proponents have the financial, managerial and technical competence needed to develop such a high-risk venture and if halibut culture can be proven to be economically viable. Future developments must be private sector driven, as the financing required for development of halibut culture will be substantial. The private sector should consider strategic alliances with successful producers of juveniles. Given that the optimal hatchery and growout technologies have still not been determined and the potential economic viability of halibut culture is unknown, a "wait and see" approach is recommended. Future hatchery research in Newfoundland should focus on controlled experiments for improving hygiene and food quality, rather than on costly pilot-scale production.

*Wolffish*

Despite the quality of the flesh of this species and the technical successes scored in developing its culture, wolffish are considered to be a low priority for development. The major impediments to its success are the low market value of the species, the lack of a private sector partner to back the required market development and positioning, and the land-based capital requirements.

It is concluded that this fish does not warrant the support of public funding for commercialization. Any future R&D and commercialization efforts should include the consideration of a collaboration with the leading company in wolffish aquaculture, Akvaplan-niva of Norway, for technology transfer and for collaborative market research.

*Witch flounder*

The economic viability of witch flounder aquaculture is considered to be highly unlikely because of the species' slow growth rates, the high capital costs of any venture (with low employment generation) and the unknown level of commitment of the private sector to this development. It is felt that the species does not warrant public funding support for commercialization or research.

*Soft shell clams*

The soft shell clam is normally harvested from the wild but recent over-fishing and a decline in the habitat for the species has created interest in culturing the species. The viability of the clam's culture in Newfoundland is unknown and cold water temperatures and slower growth may adversely affect potential viability. It is concluded that this species should not be considered as a potential species for commercial development. This is not a priority for future R&D efforts.

*Seaweeds*

It is concluded that seaweed aquaculture is still at the beginning stages of research and it is not possible at this time to evaluate the commercial potential for culture. As such, this species cannot be considered a commercial priority for the Newfoundland aquaculture industry and does not warrant the support of public funding for commercialization. It is recommended that limited, controlled and staged trials be undertaken to determine growth potential in conjunction with available expertise.

The advice given on strategic directions is based on current conditions. It is possible that changes will occur that will make a re-evaluation of the various species desirable. At any time, changes in market outlooks or biological breakthroughs may alter the potential viability of the culture of a species, either making it advisable to support development or forcing its abandonment. The evaluation framework outlined in this report is recommended as the outline to follow in such future evaluations. Finally, it is noted that each funding or support agency will have to undertake independent reviews of the individual future proposals they receive on these species. It is stressed that these reviews include the critical measure of the ability and strength of the proponent in managerial, technical/biological, marketing, processing, and financial areas.

# 1.0 INTRODUCTION

The Newfoundland Aquaculture Industry Association, in collaboration with the Department of Fisheries and Aquaculture, the Department of Fisheries and Oceans, the Atlantic Canada Opportunities Agency, the Department of Human Resources Development Canada and the Department of Development and Rural Renewal, is seeking the development of a strategic plan for the Newfoundland aquaculture industry. Burke Consulting Inc. has been contracted to prepare this plan. The attached report and appendices complete the requirements of this contract.

In collaboration with Resource Development Associates, Burke Consulting Inc. assembled a study team with extensive experience in the local, Canadian and world aquaculture industries. Targeted studies have been prepared for this report by Dr. Bent Urup of Denmark, Bergen Aqua AS of Norway, Bishop & Associates of Ontario and Mr. Cyr Couturier of Newfoundland.

The appendices attached to this report provide a detailed analysis of the Newfoundland aquaculture industry, on a species-by-species basis. For each species, an industry and market analysis is completed to determine the external opportunities and threats it is facing. An analysis of the issues affecting species development is provided along with an assessment of the current strengths and weaknesses of each sector of the local aquaculture industry. A combined assessment of the outlined internal and external factors through a SWOT analysis is used to identify the strategic issue or issues for each industry sector. Finally, for each species a common evaluation framework is used to determine the potential and priority for commercial development.

The following report is separated into four primary sections, as outlined below:

**Section 2.0 - The Background** discusses the rationale for developing this strategic plan and briefly profiles the Canadian and Newfoundland aquaculture industries.

**Section 3.0 - The Species Profile Summaries** encapsulate the detailed analysis of each species provided in the appendices, including the SWOT analysis and Evaluation Framework.

**Section 4.0 - The Issue Summary** profiles the primary issues facing the industry as a whole and summarizes the major areas of focus for each species.

**Section 5.0 - The Strategic Plan** details the proposed strategic plan for each species, outlining an action plan for industry development.

# 2.0 BACKGROUND

## 2.1 STRATEGIC PLAN

The strategic plan for the Newfoundland aquaculture industry is intended to outline the strategic issues facing each sector of the aquaculture industry and to recommend approaches to addressing these issues. NAIA has identified several reasons for completing this study, as follows:

- There has been a large public and private sector investment in the aquaculture sector and the stakeholders feel the sector needs a strategic plan to grow the industry and achieve viability.
- We need to update our priorities and make the case to government on the type of support needed to move the industry forward.
- The recent Aquaculture Roundtable meetings in Ottawa were geared toward identifying industry and provincial government support for a new aquaculture funding program. By completing a strategic plan now, Newfoundland will be well positioned to put forward its case for new funding and how it should be allocated.
- Finally, there is a need to update the prior strategic plans for mussels, steelhead trout and Atlantic salmon and also do a strategic review of additional species which has not been completed before. These species include scallops, cod, halibut, yellowtail flounder, Arctic charr, wolffish, witch flounder, soft shell clams, American eels, sea urchins and seaweeds.

### 2.1.1 Study Methodology

The primary methodologies used in the strategic analysis of the Newfoundland aquaculture industry include the following:

- Secondary data review: The review and analysis of available secondary data, including prior reports on the Newfoundland industry and its various sectors, reports on Canadian and world aquaculture, statistical data on aquaculture production, markets and prospects, and reports on the various issues facing the aquaculture industry;
- Primary research: Extensive interviews with the primary stakeholders in the Newfoundland aquaculture industry, i.e. the industry participants, suppliers, government and non-government support departments and agencies. Additional interviews with industry representatives and stakeholders in other jurisdictions throughout Canada and abroad. (A listing of those contacted for this study is provided in Table 2.1);
- Targeted studies: Industry experts have been contracted to provide reports on specific industry sectors and issues. A listing of those contracted and their specific area of study is provided in Table 2.2. These reports are appended to the study.

### **Table 2.1:** Study Contacts

***Industry Members***

Ms. Tracey Perry, Mr. Vern Watkins, Mr. Clyde Collier, Mr. John Kealey, Mr. Cory Taylor, Ms. Elizabeth Barlow, Mr. Boyd Pack, Mr. George Parsons, Mr. Terry Mills, Mr. Ed Sheppard, Mr. Job Halfyard, Mr. Joe Wiseman, Mr. Geoffrey Ball, Mr. Bill Carter, Mr. Alvin Hodder, Mr. David Walsh, Dr. Pat Dabinett, Mr. Jonathan Moir of NAV Group, Mr. Gary Wilton, Mr. David Simms, Mr. Louis MacDonald, Ms. Betty House, Mr. Ian Stewart, Mr. Roger Organ, Mr. Irvin Green, Mr. Ken Bruce

***Government/Support Agencies***

- DFA: Mr. Jerry Ward, Mr. Brian Meaney, Mr. Ron Scaplen, Mr. Shawn Robinson, Mr. Rod Penney
- ACOA: Mr. Paul Strickland, Mr. George Power, Mr. David Murrin, Mr. Ken Martin
- DFO: Mr. Jeff Perry, Mr. John Mercer, Mr. Max Grandy, Mr. Vern Pepper, Mr. John Collins, Mr. Larry Yetman
- CCFI: Mr. Glen Blackwood
- NRC: Ms. Sue Vatcher

***Regional Groups (RED Boards)***

- Ms. Tracey Perry, Mr. Harold Murphy - Coast of Bays
- Mr. Tom Hutchings - Long Range
- Ms. Linda Brett - Emerald Zone
- Mr. George Parsons - Bachelieu Zone
- Mr. Steve Moyse - Discovery Zone

***Researchers***

- Marine Institute: Mr. Nigel Allen, Mr. Cyr Couturier, Dr. Jay Parsons, Mr. Keith Rideout, Mr. Leonard Lahey, Mr. Chris Bridger, Mr. Tom McKeever
- MUN: Dr. Joe Brown, Dr. Pat Dabinett, Dr. Bob Hooper
- Other: Dr. Charles Yarish, Dr. Thierry Chopin

***Industry Groups/Organizations***

- Nova Scotia Growers' Association, Irish Salmon Growers, Finnish Game and Fisheries Research Institute, Norwegian Fish Farmers Association, Office of the Commissioner for Aquaculture

***Suppliers***

- Fab-Tech, Newfoundland Aqua Services, Eagle Fibreglass, Fukui, various suppliers to industry at Aqua-Nor

Note: Several attempts were made to contact additional stakeholders without success.

**Table 2.2: Contracted Reports**

| Participant | Description |
|---|---|
| Mr. Bent Urup<br>Aqua-Partners, Denmark | Profile of European marine finfish development, development and prospects, strategic issues impacting future development. |
| Mr. Rolf Engelsen<br>Bergen Aqua AS, Norway | Profile of the Norwegian marine finfish industry, development and prospects, primary strategic issues impacting future development. |
| Mr. Cyr Couturier<br>Marine Institute, St. John's | Profile of World and Newfoundland shellfish industries, evaluation of technical and R&D needs and issues impacting development. |
| Ms. Bonnie Bishop<br>Bishop & Associates, Ontario | Profile of international mussel husbandry methods. |

## 2.2 THE CANADIAN AQUACULTURE INDUSTRY

An excellent summary of production statistics for the Canadian aquaculture industry in 1998 was recently completed for *Northern Aquaculture* magazine by Price Waterhouse Coopers and presented in their July 1999 issue. The following paragraphs summarize the findings of this report.

In 1998 the Canadian aquaculture industry reached a production level of almost 87,000 tonnes valued at $550 million, an increase of 4% in volume and 19% in value over 1997 production. The aquaculture industry in Canada is dominated by the production of salmon from British Columbia and New Brunswick. The single largest contributor to overall Canadian production and value is the British Columbian salmon industry, which in 1998 produced 39,000 tonnes of salmon valued at $298 million.

Close to 80% of total aquaculture production was exported in 1998, reaching a level of export value of $425 million, up 24% from 1997. The vast majority of Canadian aquaculture exports are destined for the United States market.

### 2.2.1 Finfish Production

Overall finfish production in 1998 reached 65,686 tonnes valued at $502 million, up 3% in quantity and almost 20% in value from 1997. Since 1991 total finfish production in Canada has more than doubled in quantity and value from a level of just over 30,000 tonnes valued at around $250 million.

In addition to the salmon production in British Columbia and New Brunswick, this production also included 7,600 tonnes of freshwater rainbow trout, primarily from Ontario, and almost 2,400 tonnes of steelhead trout, from Newfoundland and Nova Scotia. Other finfish, primarily Arctic charr, accounted for another 300 tonnes of production.

In 1998 farmed salmon accounted for 93% of the total value of all Canadian aquaculture exports. The increasing value of Canadian aquaculture exports can be largely attributed to the increased value-added production of farmed salmon fillets and to a weak Canadian dollar. Canadian exports of farmed Atlantic salmon fillets to the United States have dramatically increased from less than 500 tonnes in 1996 to 4,000 tonnes in 1998. The value of these exports has similarly increased to over $45 million.

### 2.2.2 Shellfish Production

Shellfish production in 1998 reached 21,222 tonnes valued at $48 million, an increase of 6% in quantity and 4% in value over 1997. The primary shellfish produced by the Canadian aquaculture industry are mussels and oysters.

Mussel production increased 29% in 1998 to 14,800 tonnes. Prince Edward Island which is the country's primary mussel producer, in 1998 increased its production by 24%. In that year, PEI farmers exported almost $13 million in mussels to the United States.

Oyster production dropped by 33% in 1998 to 5,700 tonnes. British Columbia and PEI are the primary producers of oysters in Canada with additional production also coming from Nova Scotia and New Brunswick.

Other shellfish products produced in 1998 included around 700 tonnes of clams, primarily from BC, and less than 100 tonnes of cultured scallops, largely from BC and Nova Scotia.

## 2.3 THE NEWFOUNDLAND AQUACULTURE INDUSTRY

### 2.3.1 Status

#### *Production*

Although still a very small player compared with the worldwide and Canadian aquaculture industries, the Newfoundland aquaculture industry has experienced significant growth in recent years. From 1995 to 1998 total aquaculture production in Newfoundland increased from 1,029 tonnes to 2,694 tonnes, a rise of 162%. Production in 1999 is projected to total 4,286 tonnes, an increase of 59% over 1998 and a 317% increase over 1995. The value of production has shown an even more dramatic increase, from $3.5 million in 1995 to $18.0 million in 1999, a 414% increase.

Like the Canadian aquaculture industry as a whole, the Newfoundland industry accounts for most of its production value within the salmonid sector. The production of salmonids, Atlantic salmon and steelhead trout from the Bay d'Espoir region, has increased from 584 tonnes in 1995 to 2,478 tonnes in 1999, a 324% increase. The value of salmonid production has increased by 334% in this period, from $3.2 million to $13.9 million.

The mussel industry has also experienced major growth, with the value of mussel production increasing from less than $0.3 million in 1995 to $3.8 million in 1999, an increase of 1167% in value.

A summary of production statistics for the Newfoundland aquaculture industry from 1992 to 1999 is provided in Table 2.3.

**Table 2.3: Newfoundland Aquaculture Production (1992-99)**
(Tonnes)

| Species | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|
| *Finfish* | | | | | | | | |
| Salmon | 75 | 100 | 46 | 115 | 295 | 613 | 401 | 398 |
| Steelhead | 88 | 118 | 334 | 469 | 734 | 355 | 1,316 | 2,080 |
| Trout | 3 | - | - | 18 | 24 | 15 | 12 | - |
| Other* | 9 | 17 | 15 | 9 | 5 | 41 | 39 | 134 |
| *Total Finfish* | 175 | 235 | 395 | 611 | 1,058 | 1,024 | 1,768 | 2,612 |
| *Shellfish* | | | | | | | | |
| Mussels | 160 | 224 | 400 | 404 | 377 | 752 | 946 | 1,700 |
| Scallops | 2 | 3 | 12 | 11 | 19 | 11 | 0 | 0 |
| Other | - | - | - | 3 | 1 | 3 | 7 | 3 |
| *Total Shellfish* | 162 | 227 | 412 | 418 | 397 | 766 | 954 | 1,703 |
| *Total Production* | 337 | 462 | 807 | 1,029 | 1,455 | 1,776 | 2,694 | 4,286 |

Source: DFA, DFO Statistics, Statistics Canada
Note: Some minor discrepancies exist between available statistics
* Other species: for 1997 to 1999 refers primarily to cod grow-out

### *Licensing*

The number of aquaculture site licenses issued by species is profiled in Table 2.4. As this table illustrates, the Newfoundland aquaculture industry experienced a 46% growth in issued site licenses between 1995 and 1996. The sector of the industry with the largest number of issued site licenses is the mussel industry, which in 1998 accounted for 107 issued site licenses covering a total of 2,400 hectares of water.

The number of site licenses issued for the salmonid sector has grown from 30 in 1995 to 56 in 1998. Cod and scallop enterprises also have significant numbers of issued site licenses, although the number of cod site licenses has been growing while scallop site licenses have remained stagnant. Site licenses for the Arctic charr sector have dropped from a peak of 12 in 1996 to only four in 1998.

Although a gauge of the level of interest in different species, the number of site licenses is not a good reflection of industry size or growth.

**Table 2.4: Aquaculture Site Licenses**

| Species | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|
| Mussels | 75 | 104 | 119 | 107 |
| Scallops | 11 | 13 | 13 | 10 |
| Other Shellfish | 8 | 13 | 13 | 10 |
| Salmonid | 30 | 49 | 54 | 56 |
| Charr | 10 | 12 | 8 | 4 |
| Cod | 8 | 14 | 18 | 20 |
| Other Finfish | 4 | 5 | 5 | 3 |
| Total | 144 | 210 | 230 | 210 |

Source: Department of Fisheries and Aquaculture (DFA)

***Future Prospects***

The Department of Fisheries and Aquaculture is projecting future continued growth for the province's aquaculture sector. It is projected that from 2000 to 2002, total aquaculture production will increase from the current level of 4,286 tonnes to approximately 6,800 tonnes, with a corresponding increase in value from $18 million to $22.8 million. With the infusion of private capital into the salmonid sector, the total production could potentially reach 9,700 tonnes with a value of $41.9 million. Figures 2.1 and 2.2 profile projected production growth in Newfoundland aquaculture.

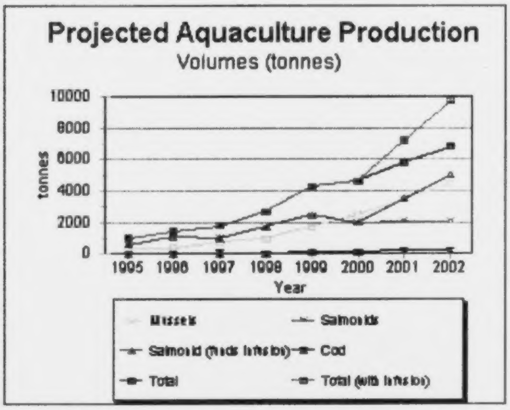

**Figure 2.1**: Projected Aquaculture Production - Volume
Source: DFA

Mussel culture is expected to lead the future expansion with total production increasing from 1,700 tonnes in 1999 to 4,500 tonnes by 2002. Salmonid production is also expected to remain steady at over 2,000 tonnes but could increase to 5,000 tonnes or more with the infusion of private capital into the industry. Seasonal cod growout is projected to increase to 200 tonnes by 2002.

It is not expected that this level of production will be achieved through increases in site licenses. Instead, production increases will be based on increasing the productivity of existing sites. For example, the current 2,400 hectares of water leased to mussel growers is more than adequate to reach forecasted production levels.

Success in reaching forecast production levels will be subject to the implementation of the strategic plan outlined in this document.

### 2.3.2 Industry Infrastructure

The existing infrastructure in place in the Newfoundland aquaculture industry primarily consists of commercial infrastructure for salmonids and mussels and R&D infrastructure in support of the development of other species.

The following paragraphs provide a snapshot of the infrastructure in place to support each species and of the current primary infrastructure gaps that must be rectified for future industry growth. A further discussion of the specific infrastructure needs of each species is presented within the species profiles attached as Appendices A to M.

#### *2.3.2.1 Commercial Infrastructure*

#### *Salmon/Steelhead*

Infrastructure for the salmonid sector is centered in the Bay d'Espoir region. Existing physical industry infrastructure includes a single hatchery, an egg incubation facility, a processing facility, a lake-cage nursery site, and several commercial growout sites. Ancillary infrastructure which has been put in place in support of the industry in recent years includes a winter access road to the primary wintering site, Roti Bay, a fish health support lab and a blood-water treatment system in the processing facility.

Additional infrastructure required in support of future industry development, which is detailed in the species analysis provided in Appendix A, includes the following:

- additional hatchery and nursery capacity;
- improved/expanded processing capacity; and
- expanded growout capacity.

#### *Mussels*

The mussel culture industry is geographically dispersed throughout the island, although the primary concentration of growers and processors is found along the northeast coast. Industry infrastructure primarily consists of gear and equipment at growout sites and processing operations. The amount of infrastructure and the level of technology utilized varies significantly from site to site.

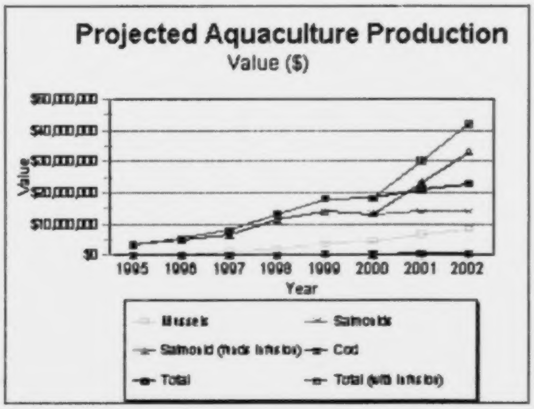

**Figure 2.2**: Projected Aquaculture Production - Value
Source: DFA

Growth in the mussel sector will require additional commercial infrastructure for both growers and processors. Equipment and infrastructure needs are further outlined in Appendix B but include the following:

- Gear and equipment for site expansion and improved efficiencies: bigger barges, graders, improved handling systems, and other technology;
- Central holding and grading facilities to reduce transportation costs of product to processors; and
- Technology for increased processor efficiencies: adequate holding systems, use of higher capacity tubs versus pans, etc.

#### Cod

The infrastructure requirements for cod aquaculture are outlined in Appendix C.

The infrastructure in place for seasonal cod growout operations varies from farmer to farmer but primarily consists of gear and equipment available from their fishing operations. The infrastructure requirements outlined for a 40,000 pound farm in the DFO report "A Growers Guide to Small Scale Cod Grow-Out Operations" includes 2 net pens, a transfer cage, boat and related equipment and a bait cutter. Further growth of seasonal growout operations will require additional investments in nets and cages. The development of large farm sites will warrant the utilization of labour-saving equipment, such as feed blowers and feed monitoring systems.

The commercialization of full-cycle cod aquaculture will require the development of new infrastructure. At present one broodstock holding facility has been constructed by a private sector company. To develop the industry a commercial hatchery will be required. In addition, a marine nursery will be required consisting of the cages, nets and ancillary equipment necessary to bring juvenile cod through one overwintering.

#### Other Commercial Infrastructure

Additional commercial infrastructure which has been put in place to support the development of other species includes the following:

- The Belleoram scallop hatchery;
- The Newfoundland Aqua Ventures' Atlantic halibut and cod broodstock holding facility in Winterton;
- The Daniels Harbour Arctic charr facility; and
- Hatchery/nursery capacity at Hopeall, Trinity Bay in support of rainbow trout production for growout.

### 2.3.2.2 R&D Infrastructure

Significant research and development infrastructure is in place to support aquaculture development in the province. Memorial University is home to major support facilities:

- The Ocean Sciences Centre and the new Aquaculture Research Facility, a major R&D facility constructed with government support to facilitate the development of the Newfoundland aquaculture industry specifically with respect to cold-water marine culture;
- The aquaculture facility of the Marine Institute of Memorial University, put in place to facilitate fresh water and some salt water research and the training of aquaculture

personnel; and
- Memorial's Bonne Bay Research Station, which has been the site of early R&D efforts on sea urchin roe enhancement.

Additional public and private sector R&D infrastructure includes:
- The Wesleyville Hatchery, the site of early development efforts on wolffish and other cold-water marine species;
- North Atlantic Aquaponics' pilot-scale eel production facility in Robinsons;
- The Sea Urchin Research Facility (SURF) in Wareham;
- Green Seafoods' sea urchin research facility in Winterton; and
- The AquaOptima recirculation facility in Cupids.

### 2.3.3 Industry Support

The commercial and research elements of the Newfoundland aquaculture industry are supported by a number of groups and agencies, many of which provide direct funding support for the industry. The following is a listing and brief discussion of the various support groups and agencies in place for the Newfoundland aquaculture industry.

#### *2.3.3.1 The Newfoundland Aquaculture Industry Association (NAIA)*

The primary support group for the industry itself is the Newfoundland Aquaculture Industry Association (NAIA).

The NAIA represents the interests of industry to the public and provides lobbying support to address industry's concerns. The NAIA has taken a leadership role in dealing with such issues as stock access for the salmonid industry and the Navigable Waters Protection Act (NWPA), issues which affect not only the Newfoundland aquaculture industry but many other areas of the industry across Canada.

NAIA has also been a primary driver behind efforts to provide industry training and is currently overseeing the implementation of industry workshops funded through the Department of Human Resources Development (HRDC) and the Atlantic Canada Opportunities Agency (ACOA). Other initiatives which the NAIA has led, with funding support from other agencies, include the yearly spatfall monitoring program, the annual industry general meeting and trade show and R&D initiatives in mussels and scallops.

#### *2.3.3.2 The Newfoundland Salmonid Growers Association (NSGA)*

The Newfoundland Salmonid Growers Association (NSGA) represents the interests of the salmonid sector in the Bay d'Espoir region. This group has been responsible, in concert with the NAIA, for the development and implementation of significant R&D initiatives in the Bay d'Espoir area. Through these groups the industry has taken a proactive role in environmental studies of the region.

#### *2.3.3.3 Government and Private Departments, Agencies and Programs*

***The Department of Fisheries and Aquaculture (DFA)***

The Department of Fisheries and Aquaculture plays a lead role in the regulation and development of the aquaculture industry. With a staff of over 20 dedicated to the aquaculture sector, this province has dedicated more human resources to the industry than any other in Canada. DFA is responsible for industry licensing and regulation and is also the lead provincial department for industry development.

### The Department of Fisheries and Oceans (DFO)

The Department of Fisheries and Oceans is the lead federal department for the aquaculture industry. The department has a small staff dedicated to aquaculture in the province, who have been instrumental in various industry developments, including seasonal cod growout, salmon broodstock evaluation and environmental studies in Bay d'Espoir. The department also administers the Fish Health Protection Regulations, Introductions and Transfers policy and the Navigable Waters Protection Act.

### The Atlantic Canada Opportunities Agency (ACOA)

The Atlantic Canada Opportunities Agency has been the primary public funding support agency for the Newfoundland aquaculture industry. Through the various programs it administers, such as the Aquaculture Component of the Economic Renewal Agreement (ACERA) (in conjunction with DFA and DFO) and the Strategic Regional Development Agreement (SRDA), this agency has also been a primary supporter of research and development programs and infrastructure development. ACOA is also the lead agency responsible for the post-TAGS FRAM-ED funding program.

### Human Resources Development Canada (HRDC)

Human Resources Development Canada has been a major funding support agency for both the commercial and developmental sectors of the aquaculture industry through its direct support for labour and training initiatives.

### Department of Development and Rural Renewal (DDRR)

The Department of Development and Rural Renewal is the provincial department primarily responsible for supporting rural economic development throughout the province. DDRR is currently acting as a co-administrator, with ACOA, of the Aquaculture Working Capital Program in support of mussel industry development in the province. This department is also a co-administrator of the FRAM-ED program.

### The National Research Council (NRC)

Through its Industrial Research Assistance Program (IRAP), the National Research Council, has been instrumental in supporting research and development and technology transfer initiatives for the Newfoundland industry. These applied initiatives require direct industry support.

### The Canadian Centre for Fisheries Innovation (CCFI)

The Canadian Centre for Fisheries Innovation is owned by Memorial University of Newfoundland and has been funded to date by ACOA. This group provides funding support for collaborative applied research and development initiatives involving industry and researchers at Memorial University of Newfoundland. The Centre has been a primary support agency for industry-supported R&D initiatives in mussels, scallops, cod, Atlantic halibut, yellowtail and witch flounder, sea urchins, Arctic charr, and wolffish.

# 3.0 SPECIES PROFILES AND ASSESSMENT

There are 13 species currently under development or consideration in Newfoundland. In this section, a summation of the detailed species profiles attached in the appendices is presented with a focus on the state of commercial and technical development. For each of the species under consideration, Appendices A to M include detailed information in the following areas:

- ***Industry Profiles:*** On a species-by-species basis, a profile is given of the world aquaculture industry, concentrating on the primary producers of each species.
- ***Market Profiles:*** The primary markets for each species, the market trends and future potential are identified and analyzed.
- ***Species Aquaculture in Newfoundland:*** The development and current situation for each species in Newfoundland is profiled.
- ***Issue Identification and Analysis:*** From a comprehensive listing of issues, the appropriate issues for each species are identified and discussed in terms of their relevance and impact. For each species, issues are identified from the list provided in Table 3.1.
- ***SWOT Analysis:*** The SWOT analysis brings together the discussion of internal and external factors facing each species to determine both the potential positive matches between local industry strengths and external opportunities and the negative warning signs related to local industry weaknesses and potential external threats.
- ***Evaluation Framework:*** A standard evaluation framework is presented to allow for the comparison of the potential of each species.

| **Table 3.1:** Issues Under Consideration |
|---|
| Broodstock Issues |
| Hatchery Issues |
| Growout Issues |
| Processing Issues |
| Marketing Issues |
| Technology Issues |
| Fish Health Issues |
| Regulatory Issues |
| Economic Issues |
| R&D Issues |
| Financing and Investment Issues |
| Infrastructure Issues |
| Human Resource Issues |

### 3.0.1 Species Categorization

Each of the species profiled in this section can be categorized in various ways. For the purposes of this report, the species have been grouped into three basic stages of development: commercial, developmental, and research. For each species, the stage of development in Newfoundland may differ from the species' status worldwide. For example, although seaweed culture is a major contributor to the world aquaculture industry, the culture of seaweed has not been tried in Newfoundland and is only now receiving consideration. Species categorization was completed based on the following definitions:

- *Commercial species:* These are species with an established track record of commercial production.
- *Developmental species:* This grouping is composed of species in the pre-commercial stage of development, where some commercial production may have taken place either over a short period or on a small scale. This category also includes species whose biological parameters for production have primarily been identified but are still undergoing pilot-scale development and commercial evaluation.
- *Research species:* This category includes species whose biological requirements are not well understood and those for which the routine production methods are not yet developed.

**This categorization does not imply a ranking of these species or their economic potential**. The determination of species ranking and priorities is presented individually in each species' Evaluation Framework, with a summary of species priorities provided at the end of this section. The species-by-species discussion outlined in the following pages follows this order: commercial, developmental and research species. For each species a brief summary of its industry and market situation is provided, along with its current status in Newfoundland. The SWOT analysis and Evaluation Framework is included, along with basic recommendations regarding the priority each species should be given for commercial development. Detailed strategic recommendations for the industry and each species are outlined in Section 5.0 - Strategic Plan.

## 3.1 COMMERCIAL SPECIES

### 3.1.1 Atlantic Salmon/Steelhead Trout

**Industry Profile**

Today, salmonid aquaculture can be described as a dynamic, aggressive and vibrant worldwide industry. From its main producing areas, located in Europe, Chile and North America, production levels have exploded over the last ten years, from 200,000 tonnes in 1989 to approximately 900,000 tonnes this past year. Several species are farmed, including Pacific, Atlantic and coho salmon and sea trout. Atlantic salmon is the king of the industry, comprising two-thirds of the total production.

The main producing regions are clearly Norway and Chile. The fjiords of Norway are home to a $2.4 billion (Cdn$) industry which employs 20,000 directly and indirectly. There, 770 farm sites together produce approximately 343,000 tonnes of round weight salmon and 47,000 tonnes of trout and Arctic charr. The dynamic nature of the industry is reflected in the growth that these production figures represent. Since 1986, the production of salmonids in the country has grown from 50,000 tonnes, almost a 700% increase.

Chile occupies the Number Two position in the industry. Its recent growth rate is as remarkable as that of its northern competitor. Since 1992, salmonid farming has more than tripled in size from 50,000 tonnes to 160,000 tonnes. The industry's rise has been attributed to three main factors: a long coastline with many protected areas suitable for salmonid farming, low costs in labour, feed and water, and a government whose resource policies favour the development of aquaculture in the country.

The outlook for the industry continues to be for more growth, particularly in Norway and Chile. It is projected that during the next decade, salmon production alone will reach 1.9 million tonnes. The western coast of Canada, which produced 42,000 tonnes of salmon in 1998, has good potential in salmon if the British Columbia government lifts the current moratorium on aquaculture growth there.

Worldwide other trends include the continuation of a process of industry consolidation, which began in the 1990s, and a downward pressure on prices, which will be the direct result of both the expected increased production and the enhanced economies of scale produced through consolidation. These trends will particularly affect the smaller producers' ability to compete.

**Species Aquaculture in Newfoundland**

The Newfoundland salmonid industry is located in Bay d'Espoir, the only area of the province that is suitable for the growing of steelhead trout and salmon. Production from this area has risen from less than 200 tonnes in 1992 to almost 2,500 tonnes in 1999. Steelhead is the primary species raised, making up between 70% and 80% of total production on a yearly basis.

The industry is composed of seven individual companies, each forecasting production levels ranging from zero to 1,500 tonnes. The development of the Newfoundland industry has not been a steady process of improvement over the years. Major difficulties have had to be overcome in dealing with the local environment, including hurricane-force winds, ice movements and disease outbreaks. As well, the industry has been constrained by government regulations concerning the choice of stocks that can be used. The approved strains have been poor performers and losses have been sustained as a result.

Other significant factors that have stifled the growth of this industry include:

- An emphasis on job creation over corporate profitability;
- A dependence on government support;
- A hatchery that concentrated on production of large numbers of small fish, a practice which often compromised quality and health;
- A lack of processing expertise in the Bay;
- The absence of an experienced, successful salmonid farming corporation in the Bay;
- A lack of business planning and management skills;
- The use of a steelhead strain with high FCRs and mortality rates; and
- Losses which reduced the equity position of entrepreneurs.

In the latter half of the 1990s a number of studies were carried out on the industry. Mitchell Planning Partners reviewed the state of the industry in early 1998. The review singled out a series of issues that were impeding the progress of the industry and proposed a major strategic initiative to re-direct the industry toward profitability. Canadian Aquaculture Systems were engaged in the same year to carry out an operational audit of the largest company in the region, SCB Fisheries. The audit underlined similar concerns to those raised by the Mitchell Planning study and also made several recommendations for overcoming the obstacles. One year later, a review of the industry was undertaken by Mr. Tim Edwards of Caleq Fisheries. Again, several issues were highlighted and recommendations made.

Recently, a number of changes have been introduced to Bay d'Espoir. SCB Fisheries have reorganized its operations, reducing its labour force and making adjustments to its hatchery and processing procedures. Several environmental issues have been addressed and a management plan that will allow for enhanced growth and survival has been put in place. Thanks to effective lobbying, government regulations were changed to allow for the use of better performing stocks. As a direct result of these changes, better fish growth and reduced mortalities have been recorded. These have in turn resulted in rapid and dramatic increases in production in the last year of the century. With these changes established, the outlook for the industry has changed considerably and is now seen as having significantly improved potential.

### SWOT Analysis

Table 3.2 summarizes the strengths, weaknesses, opportunities and threats facing the development of salmonid aquaculture in Newfoundland. These factors are based on the assessment of industry and market conditions and issues facing development (See Appendix A).

## Table 3.2: SWOT Analysis - Salmon/Steelhead

| Internal | |
|---|---|
| Strengths | Weaknesses |
| • Bay d'Espoir environment suitable for Atlantic salmon and Steelhead trout production.<br>• Improved access to better performing stocks, to diploid trout.<br>• 1999 as best grow out season in history, excellent growth, lower mortalities. Much improved performance of new Steelhead strain over earlier strain (very large reductions in FCRs and mortality)<br>• Committed and dedicated farm owners, workers and industry resource personnel.<br>• Successful entrance into the Japanese steelhead market by two independent growers. Development of marketing arrangement by one company with a major fishing company.<br>• Improved size and quality of fish being produced by the hatchery.<br>• Improvements in processing plant efficiency and performance.<br>• No major problems to date with sea lice or ISA. | • Burden of past history, poor financial performance due to:<br>  • Past social focus rather than a corporate focus;<br>  • Past dependence on various government support programs, a focus on accessing government support over best business practices;<br>  • A hatchery focused on producing large numbers of small fish which were often of compromised health and quality;<br>  • The lack of processing expertise in the Bay, resulting in a highly labour intensive, inefficient plant operation with detrimental impacts on quality;<br>  • Dependence on a strain of steelhead with high FCRs and mortality;<br>  • Husbandry not matched to site-specific conditions.<br>• Carrying capacity limitations due to overwintering..<br>• High costs of production compared to competitors for both hatchery and growout. Need to improve. economies of scale - move farms toward 500 tonnes or more production levels.<br>• The absence of an experienced, successful salmonid farming corporation in the Bay, having the financial and operational abilities to lead the industry.<br>• A lack of business planning and management skills.<br>• Entrepreneurs have utilized their substantial equity investment in farm establishment and expansion. Losses have reduced their equity position and placed constraints on cash flows.<br>• Lack of focus on marketing and market development.<br>• Loss of public and private sector investor confidence<br>• Variable husbandry practices, lack of "Best Practices".<br>• Persistent disease problems, current furnuculosis threat.<br>• Underutilization of available cost-saving technologies.<br>• High transportation costs versus mainland competitors, i.e., getting feed into Bay d'Espoir and getting product out to market. |

### Table 3.2: SWOT Analysis - Salmon/Steelhead

| External | |
|---|---|
| Opportunities<br>• Potential for significant industry growth.<br>• Entrepreneurial opportunities:<br>  ◦ New hatchery;<br>  ◦ Improved processing operations;<br>  ◦ Grow out joint venture, purchase, new development.<br>• Access to lucrative US market for potential international partners/ investors.<br>• Opportunity for comprehensive cost reduction, integration of new technolgies.<br>• Opportunity to demonstrate the profitability of new strains (significant profitability improvements in 1999). | Threats<br>• Industry is a small player in the worldwide salmonid sector, a price taker. Declining prices could impact on viability.<br>• Some limitations on access to strains.<br>• Lack of demonstrated profitability.<br>• Obtaining access to the investment required for survival and future development. |

**Evaluation Framework**

As outlined in the standard species evaluation framework presented in Table 3.3, salmon/steelhead should remain a high priority for development in Newfoundland.

### Table 3.3: Salmon/Steelhead - Evaluation Framework

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Bay d'Espoir is the only region in the province suitable for salmonid development, the only area where superchill can be avoided. Development is restricted by limitations on overwintering sites. | + |
| Production Potential - Biological | • Area has proven its ability to support salmon and steelhead production. Recent performance of new steelhead strain has been very promising. Salmon still facing threat of furnuculosis. | + |
| Production Potential - Economic | • Salmonid aquaculture is a proven, viable industry on a worldwide basis.<br>• Industry has not proven itself to be economically viable in Newfoundland. Improvements in stock performance (mortalities, FCRs) and in cost reduction offer the potential to achieve success. | +<br>- |
| Marketing Potential | • Market for Atlantic salmon has expanded enormously over the past decade in the US and Europe. Species established as a commodity. Newfoundland is a very small player in the industry and is a price taker.<br>• Newfoundland has the potential to establish itself as a larger player in the US steelhead market. However, steelhead priced at a significant discount to salmon.<br>• Two producers have gained entry to the very strong Japanese steelhead market in 1999. Potential for longer term involvement unknown.<br>• One company has established a marketing relationship with a major fishing company. Offers the potential for greater market planning and development. | + |

### Table 3.3: Salmon/Steelhead - Evaluation Framework

| | | |
|---|---|---|
| Human Resource Capabilities | • Management and leadership skills lacking in the industry.<br>• Dedicated and experienced entrepreneurs and staff.<br>• Lack of experienced technical personnel with outside training, experience in successful operations. | -<br>+<br>- |
| Availability of Capital - Private | • Existing industry players have utilized their substantial equity investment in farm establishment and expansion. Losses have reduced their equity position and placed constraints on cash flows. These palyers generally lack the ability to inject additional capital.<br>• Investment prospecting required to attract new investment for joint venture, sale or new development. | - |
| Availability of Capital - Public | • Public sector has been extremely supportive of industry development, investing very large amounts of capital.<br>• Negative track record has reduced the willingness to invest additional funds until positive results are achieved. | +<br>- |
| Employment Generation Potential | • Sector is the most important in terms of job creation in the Bay d'Espoir region. In the past development has been driven by a social job creation agenda. The industry must undertake cost reduction and reduce labour inputs. Only cost competitive companies will be able to survive in this competitive industry. | + |
| Stage of Development - Timing to Commercialization | • The industry is considered commercial. Efforts must focus on improving the viability of operations.<br>• External private investment could expand the industry in a relatively short time frame. | + |
| Assessment | • Salmonid aquaculture is a highly competitive business where only those operations producing a high quality fish, with low mortality rates and low FCRs, and with a competitive cost structure will enjoy long-term survival and success.<br>• Improvements offer the potential for development of the Bay d'Espoir salmonid sector as a viable business sector. Steps have been taken to undertake many of the required improvements and the result has been much better performance. | + |

**Recommendations**

- Salmonid aquaculture should continue to be considered a high priority for commercial development in the province. Although the industry has a track record of poor financial performance, indications are that steps are available (and are being taken) to improve viability.
- The past history of the industry has burdened companies with heavy debt loads and low cash reserves. This constrains the ability of entrepreneurs to undertake required capital and technological improvements and to expand operations to take advantage of greater economies of scale. Investment prospecting is required to attract the new investment required for industry growth and survival. The focus of prospecting should be on firms that

provide additional value added beyond investment, in the areas of management and leadership, marketing and operations.

- Industry efforts to reduce costs, increase economies of scale and increase collaboration should receive public support. Private sector initiatives to increase hatchery capacity and improve processing capabilities also warrant public consideration.

### 3.1.2 Mussels

**Introduction**

The worldwide production of mussels, from both wild and aquaculture sources, has been in the range of 1.2 to 1.3 million tonnes for the past ten years. A vast majority of this production is from Asia and Europe. Europe is the largest producer of mussels, with Spain producing approximately 130,000 tonnes and the Netherlands and Denmark each producing approximately 100,000 tonnes. Production in Europe has dropped from a peak of 600,000 tonnes to around 500,000 tonnes. Similarly, production in Asia has also declined from a peak of 600,000 tonnes to around 400,000 tonnes.

North America is the smallest of the major mussel producing regions, with approximately 2% of total world production. The United States experienced declining landings for the past seven years, with the total 1997 production of 2,011 tonnes at only 47% of the 1990 total. The Canadian production of mussels is based in the four Atlantic provinces. Between 1986 and 1997, production rose from 2,062 tonnes to 11,463 tonnes with total farm-gate value rising from $3.4 million to $13.7 million. Total production in 1998 increased to close to 15,000 tonnes, with PEI's production rising to over 12,000 tonnes.

**Market overview**

The largest trade markets for mussels are found in Europe and North America. Europe is the largest market, with annual consumption in the 300,000 tonne range. About half the supply is sold fresh in shell, with the balance divided about equally between frozen meat and canned/bottled products. Consumption levels for mussels in Europe are high, with French per-capita consumption at 1.6 kg per person, over 50 times that of American consumption levels. Canadian mussel consumption is approximately 0.27 kg per person.

Canadian mussel production is almost entirely sold within North America, with 56% staying within Canada and the remaining 44% sold to the United States. A total of 99% of exports come from aquaculture operations and are sold as a live fresh product.

In 1997, 78% of the Canadian mussel market was supplied by domestic production. The remaining 22% consisted of frozen, value-added products, primarily from New Zealand. Total consumption has shown strong growth through the 1990s, more than doubling from 3,843 tonnes in 1990 to 8,323 tonnes in 1997.

The United States market for mussels has also experienced strong growth throughout the 1990s, growing from 5,754 tonnes in 1990 to 13,688 tonnes in 1997. Over this period of time the United States market has become more dependent upon imported mussels, with imports increasing from 2,643 tonnes, or 46.1% of total supply, in 1990 to 12,204 tonnes, or 89.2% of the total mussel supply, in 1997. Canada accounted for 40.9% of total US mussel imports in 1997 and combined with New Zealand accounted for over 98% of imports. Canada is the dominant player in the US fresh mussel market, centred primarily in the northeastern United States. New Zealand is the dominant supplier to the value-added market segment. Both market segments have experienced strong growth.

### The Newfoundland mussel industry

The development of mussel aquaculture in Newfoundland dates back about 18 years. The commercial production of mussels has evolved over the past ten years. In the 1990s mussel production has grown from less than 100 tonnes, to 946 tonnes in 1998 and approximately 1,700 tonnes in 1999.

The mussel industry in Newfoundland is the largest sector of the industry in terms of the number of people involved, licenses and water utilized, and geographic dispersal. In 1998, there were 107 licensed mussel sites in the province covering a lease area of approximately 2,500 hectares.

Although the industry has a large number of leaseholders the vast majority of industry production is derived from the top 10-12 producers. Newfoundland mussel sites are underutilized for the most part with current production levels being produced from approximately 20% of the available lease area.

### SWOT Analysis

Table 3.4 summarizes the strengths, weaknesses, opportunities and threats facing the development of mussel aquaculture in Newfoundland. These factors are based on the assessment of industry and market conditions and issues facing development (See Appendix B).

**Table 3.4: SWOT Analysis - Mussels**

| Internal | |
|---|---|
| Strengths | Weaknesses |
| • A group of 10-15 dedicated, full-time growers who are increasing production to economic levels (500,000 lbs+) and are spurring the expansion of the industry.<br>• Biophysical conditions are suitable for mussel culture in many areas.<br>• Potential exists for considerable industry expansion.<br>• Public sector financing programs are in place in support of industry development.<br>• Development of secondary production is expanding sales and marketing opportunities. | • Production highly variable from site to site, growers have not been meeting production targets.<br>• Majority of sites held by part-time growers, not fully utilizing sites to their productive capacity.<br>• Most growers and processors have limited available equity to support growth and cost reduction programs.<br>• Individuals generally are unwilling to consolidate efforts in grow-out, processing and marketing.<br>• Lack of management and equity often makes it difficult to obtain financing from existing programs.<br>• Distribution difficulties: high transportation costs versus mainland competitors; limited competition and rising costs in trucking; for fresh product the timeframe for trucked delivery to market is longer than the competition.<br>• Very few areas with the "critical mass" of production required for economic viability.<br>• Growers operating at long distances from processing plants subjected to high transportation costs, due to: inability to ship full truck load volumes and shipping a high percentage of wastage (yielding only 30-40% marketable mussels). |

### Table 3.4: SWOT Analysis - Mussels

| External | |
|---|---|
| Opportunities | Threats |
| • Potential for significant industry growth.<br>• Other Atlantic Canadian provinces are limited in their future growth potential.<br>• Entrepreneurial opportunities:<br>  • expanded production;<br>  • more efficient, cost effective processing.<br>• Opportunities to attract investment to support industry growth.<br>• North American markets for fresh and secondary products strong and growing.<br>• European markets with demand exceeding available supply.<br>• Opportunity for comprehensive cost reduction, integration of new technologies. | • Industry is a small player in the worldwide mussel sector, a price taker. Declining prices could impact on viability, although prices have been very stable.<br>• Obtaining access to the investment required for survival and future development.<br>• User conflicts and regulatory restrictions. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.5, mussel culture has the potential for development as a significant, profitable industry for the province if backed by strong managerial, marketing and technical expertise. The mussel sector deserves consideration as a high priority for continued development.

### Table 3.5: Mussels - Evaluation Framework

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Newfoundland environmental conditions suitable for mussel culture along large areas of the coast. Survival range of -2.0° to 25° C and optimal growth conditions of 10° to 20° C achievable. Potential for growth and productivity highly site specific. Need to avoid moving ice. | + |
| Production Potential - Biological | • Newfoundland has proven ability to support mussel culture. | + |
| Production Potential - Economic | • Mussel culture is a proven, viable industry on a worldwide basis. | + |
| | • Due to small farm sizes/ low production the industry does not have a track record of profitability in Newfoundland. | - |
| | • Growth to an economic scale for growout and processing is taking place for a small group of companies. | + |
| | • Potential for considerable expansion exists but must be based on sound marketing and business plans. | + |

## Table 3.5: Mussels - Evaluation Framework

| | | |
|---|---|---|
| Marketing Potential | • The North American market for fresh and secondary mussel products has experienced strong growth and this growth is expected to continue. | + |
| | • Newfoundland has the potential to establish itself as a larger player in the North American market with increased production. | |
| | • Opportunities exist in European markets where demand exceeds supply at certain times of the year. | |
| | • Secondary production has the potential to remove the competitive disadvantages Newfoundland faces in the fresh mussel market with respect to transportation and shelf life. | |
| | • Consolidated marketing of Newfoundland product by a reduced number of companies beneficial to the industry. | |
| | • Challenges exist in product distribution, especially for fresh product. | |
| Human Resource Capabilities | • Management, leadership and business skills lacking in the industry. | - |
| | • Development of the industry needs to focus on full-time participants who are making the commitment to develop/hire required managerial, business and technical expertise. A small group of dedicated entrepreneurs is developing. | + |
| Availability of Capital - Private | • Existing industry players have utilized their substantial equity investment in farm establishment and expansion. Losses have reduced their equity position and placed constraints on cash flows. These players generally lack the ability to inject additional capital. | - |
| | • Investment prospecting required to attract new investment for joint venture, sale or new development. However, generally individuals are reluctant to dilute their ownership to attract the equity required to grow their business. | |
| Availability of Capital - Public | • Public sector has been extremely supportive of industry development, investing very large amounts of capital. | + |
| | • Funding programs are in place to meet the needs of industry (ACOA, Working Capital Fund). | + |
| | • Due to historical losses and inability to meet projections, firms often find it challenging to meet the criteria established by the lending agencies. | - |
| | • Industry lacks the private capital required to lever public funding. | - |
| Employment Generation Potential | • Sector potentially has the best potential of all industry sectors for job creation in the province. Job creation possible in large areas of the province, providing jobs in rural communities (Example of Fortune Harbour which has benefitted considerably from industry development). | + |

**Table 3.5: Mussels - Evaluation Framework**

| | | |
|---|---|---|
| Stage of Development - Timing to Commercialization | • The industry is considered commercial. Efforts must focus on improving the viability of operations and expanding industry production.<br>• External private investment could expand the industry in a relatively short time frame. | + |
| Assessment | • Mussel aquaculture has significant potential for the development of a long-term profitable growth industry based in rural Newfoundland. Newfoundland's potential for growth exceeds that of the other Atlantic Provinces. This growth could position Newfoundland as a significant player in the North American mussel market. The development of secondary production provides new market opportunities and reduces competitive disadvantages versus fresh production. | + |

**Recommendations**

- Mussel culture should continue to be considered a high priority for commercial development in the province. Although the industry has a track record of poor financial performance indications are that steps are being taken to improve viability for a group of dedicated, full-time industry participants.
- The past history of the industry has burdened companies with heavy debt loads and low cash reserves. This constrains the ability of entrepreneurs to undertake required capital and technological improvements and to expand operations to take advantage of greater economies of scale. Investment prospecting is required to attract the new investment required for industry growth and survival.
- Industry growth should be supported when backed by sound marketing and business plans.
- As production grows, secondary processing represents a potential opportunity for industry diversification.
- Transportation costs are a significant cost of goods produced. Industry requires a comprehensive cost reduction strategy to enhance competitiveness. Efforts to reduce transportation costs to processing operations through pre-grading and through collaborative and centralized holding and distribution should be investigated. Stocking density and other husbandry issues are also factors in achieving greater product consistency and improving marketable yields.
- Regionalization of processing capacity may be necessary in the future to reduce the costs related to transporting mussels for processing over long distances. Capacity additions have to be based on sound business plans backed by adequate product supply and established marketing relationships.
- Continued collaborative efforts must be taken to improve the regulatory environment, to develop a consistent and fair policy framework for the aquaculture industry, recognizing the role and rights of aquaculturists in the marine environment.

## 3.2 DEVELOPMENTAL SPECIES

### 3.2.1 Atlantic cod

**Introduction**
Cod aquaculture is in the early stages of commercial development. Although production is low at present the interest in cod aquaculture is increasing in Norway, the United Kingdom and Atlantic Canada, spurred by a declining wild fishery and improvements in market demand and pricing. Two approaches to cod aquaculture are being taken in Newfoundland, the seasonal ongrowing of wild "trap" cod, caught by fishermen and ongrown for five to six months, and the development of full-cycle cod aquaculture.

In the last few years, total cod landings from the wild fishery have been at historically low levels, because of the lack of Canadian production. The outlook is for a continued scarcity of wild cod. In 1999 the Barents Sea stock, the Baltic stock, and the North Pacific stock, all saw catches reduced. Scientific advice is for a major decrease in the Barents Sea cod quota, and the outlook is for at least a 200,000 tonne reduction in overall quota for 2000. At the same time, the decline in landings of other whitefish, such as Alaskan Pollack and Hake, have put a severe strain on world whitefish markets.

**Market overview**
Decreasing world supply of all groundfish species, in particular declines of most of the major cod stocks, coupled with increasing demand for premium quality fish has created an environment where the market opportunity for aquaculture production of cod has never been better.

The two primary markets for cod products are Europe and the United States. Europe is the major consuming region for cod in the world, consuming primarily salt cod and fillets. The United States used to be the largest cod consuming country, taking the overwhelming share of the Canadian cod that was produced. When the Canadian fishery collapsed in the early 1990s, US consumption dropped as well. Consumption has been slowly rebounding in recent years.

The cod market is very large and diverse yet the total supply of cod has been decreasing over the past few years, and is expected to decline further in the next three to five years. As a result, there is a supply imbalance, and very strong demand for reliable supplies of cod. In the United States, this has resulted in several million pounds of fresh cod fillets being flown in from Iceland. The supply imbalance has placed upward pressures on cod prices in Europe and the United States, especially for high quality fresh cod.

Another potential niche market for cultured cod is the live fish trade in major Chinese ethnic population centres. High priced markets exist in centres such as Toronto, Montreal, New York and Boston for consistent supplies of live marine fish.

**Species aquaculture in Newfoundland**
Until recently the development of cod aquaculture in Newfoundland was spearheaded by Sea Forest Plantation Limited. This company established sites for the ongrowing of trap cod and trained hundreds of Newfoundland fishermen in cod growout techniques. Development of this business was

hampered by the onset of the cod moratorium. The company also initiated the research on full-cycle cod aquaculture and operated its own hatchery which unfortunately was lost to fire.

The past three years has seen a resurgence in the interest in the ongrowing of trap cod with the resurrection of cod quotas. A small group of fishermen have been successfully catching, holding and growing cod to double their initial size on a seasonal basis. Research in full-cycle cod aquaculture has continued at Memorial University's Ocean Sciences Centre. This past summer 50,000 cod juveniles were produced at the OSC by the current private sector company leading cod aquaculture development, Newfoundland Aqua Ventures.

**SWOT Analysis**

Table 3.6 summarizes the strengths, weaknesses, opportunities and threats facing the development of Atlantic cod aquaculture in Newfoundland. These factors are based on the assessment of industry and market conditions and issues facing development (See Appendix C).

**Table 3.6: SWOT Analysis - Atlantic cod**

| Internal | |
|---|---|
| Strengths | Weaknesses |
| • Newfoundland has a biophysically conducive environment for cod aquaculture in many areas.<br>• Established markets, processing, and distribution capabilities and networks exist.<br>• Strong current demand for cod and other white flesh fish<br>• Farmed cod offers product and quality advantages:<br>  • High processing yield (up to 45% fillet yield from HOG versus 32% to 35% for wild fish).<br>  • Cod raised from hatchery are likely to have minimal to non-existent incidence of parasitism.<br>  • Harvesting procedures result in a lack of bruising and blood spots providing superior product quality and a longer shelf life. | • Unless and until farmed cod is differentiated from wild cod in the market, it will be susceptible to supply and demand patterns of wild cod/white flesh fish.<br>• Market demand for farmed cod is not well delineated due to limited availability. |
| *Seasonal Grow-out*<br>• Cod has proven to be extremely hardy with very few disease problems. Successful marine growout has been achieved in Newfoundland.<br>• Extensive training program has been undertaken throughout Province.<br>• Reduced risks associated with the five to six month cycle for seasonal grow-out versus the multi-year cycle for full cycle culture.<br>• Reduced capital outlays associated with seasonal grow-out. | *Seasonal Grow-out*<br>• Seasonal cod grow-out is reliant on an undependable supply of cod from the wild cod trap fishery. (The FRCC will recommend a reduced cod fishery in 2000.)<br>• Uncertainty associated with feed supply and the reliance on wild feed (access, cost, quality).<br>• Lack of management and husbandry skills amongst growers.<br>• Some texture problems have been encountered in processing cod from grow-out operations. Different handling/processing protocols are required for farmed cod vs wild cod.<br>• The harvesting of all seasonally grown out cod at the same time can cause processing and marketing challenges. |
| *Full-cycle culture*<br>• Private sector willing to invest. Demonstrated success would likely trigger significant private sector investment to grow industry.<br>• Excellent human resource base | *Full-cycle Culture*<br>• Full intensive grow-out not yet undertaken in Newfoundland on a commercial scale.<br>• A commercial scale cod hatchery does not yet exist in Newfoundland.<br>• Financial viability of hatchery rearing and full-cycle culture has yet to be proven.<br>• Hatchery reared juvenile cod have not yet been raised to market size.<br>• Hatchery and intensive grow-out require heavy capital investment. |

**Table 3.6: SWOT Analysis - Atlantic cod**

| External | |
|---|---|
| Opportunities<br>• Market opportunities for by-products (roe, milt, liver, heads)<br>• Decline in availability of wild cod and other white flesh fish (recent decline in Barents Sea stocks) is likely to strengthen demand.<br>• The quality and consistency of supply that is possible present opportunities for premium pricing/niche markets. In their search for product to fill the demand left by declining wild resources, large United Kingdom retail chains have recently expressed interest in cod aquaculture in Newfoundland.<br>*Seasonal Grow-out*<br>• Depending on the availability of wild cod, the potential exists to expand seasonal grow-out.<br>• Control of harvest timing and market entry offers opportunities to achieve price premiums.<br>*Full-cycle Culture*<br>• Private sector initiative is proposing the development of a cod hatchery. This could provide juveniles for intensive and seasonal grow-out.<br>• EU Cod Commercialization Project will provide participants access to leading edge infrastructure, expertise and technology. | Threats<br>• A rebound in wild cod supplies would place downward pressure on prices (not likely in the near future).<br>*Seasonal Grow-out*<br>• Without a reliable source of cod, attracting investment capital will be difficult, and grow-out operations will be subjected to a high degree of risk.<br>• Fishers' interest in seasonal cod growout could be limited by potentially less risky alternate opportunities (such as crab, shrimp and other fisheries).<br>• Reliance on wild feed poses threats of availability (seasonal bait freezing and cold storage limitations), cost, FCRs and quality.<br>*Full-cycle Culture*<br>• Inability to develop hatchery or intensive grow-out as economically viable. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.7, cod aquaculture and seasonal grow-out offer significant opportunities for development.

**Table 3.7: Atlantic Cod - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Areas of Newfoundland's marine environment are conducive to cage culture of Atlantic cod.<br>• Seasonal cod grow-out has been undertaken in many of the bays around the Province.<br>• Year-round marine grow-out is restricted by ice conditions. | + |
| Production Potential - Biological | • Extremely hardy fish, withstand handling well, relatively little difficulty with disease.<br>• Hatchery and grow-out protocols are well understood and have been successfully demonstrated in Newfoundland.<br>• Cannibalism can be a problem with intensive juvenile production unless careful grading and feeding regimes are maintained.<br>• Research in strain selection may produce gains in growth and maturation rates | + |

## Table 3.7: Atlantic Cod - Evaluation Framework

| | | |
|---|---|---|
| Production Potential - Economic | • Not yet a proven commercial species, although Norwegian farms now approaching commercial scale. Commercial scale operations are under development in the UK and Canada (Newfoundland).<br>• Seasonal cod grow-out has been successfully conducted in Newfoundland. Positive economic results have been demonstrated, however feed costs and FCR are critical issues that must be further delineated. | -<br>+ |
| Marketing Potential | • Very strong world demand for Atlantic cod and white flesh fish in general.<br>• Decreasing world supply of wild cod and white flesh fish appears to be a trend.<br>• The attributes of farmed cod (controlled size; availability; quality premium, etc.) present tremendous marketing potential.<br>• Product differentiation (farmed cod from wild cod) may be required to extract full value in the market. | +<br>- |
| Human Resource Capabilities | • World class scientific and technical human resources in Newfoundland's public and private sectors.<br>• Newfoundland's participation in the EU Cod Commercialization Project will provide access to additional international resources.<br>• Extensive cod grow-out training program conducted in early 1990s has produced a broad base of fishers trained in basics of marine grow-out of cod<br>• Management and husbandry skills will require development as the sector grows. | +<br>- |
| Availability of Capital - Private | • Significant private capital has been expended on cod aquaculture development in Newfoundland.<br>• Significant private capital is proposed to develop a cod hatchery and commercial grow-out.<br>• Private capital is available for investment, joint venturing in cod aquaculture (United Kingdom, Canadian and United States sources). | + |
| Availability of Capital - Public | • Public sector funding was provided to enable the cod grow-out training initiatives, to assist Sea Forest Plantation Ltd. in establishing its cod hatchery in Placentia, and more recently to undertake the cod grow-out pilot project under ACERA.<br>• It appears likely that public funding agencies would be receptive to participating in a sound, private sector led cod aquaculture initiative. Support will be dependent upon evidence of a strong business case, adequate technical and management input, and sufficient private capital investment to lever public funds. Evidence of commitment and financial "staying power" will likely be required. | + |

## Table 3.7: Atlantic Cod - Evaluation Framework

| | | |
|---|---|---|
| Employment Generation Potential | • The employment generation potential of intensive cod aquaculture is similar to salmonids in scale and activity. The level and type of employment is roughly comparable to other marine culturing of finfish. The potential for large scale development of cod aquaculture in Newfoundland appears attractive, given the current market situation, the state of world (wild) cod supply and the conducive conditions in Newfoundland.<br>• Seasonal cod grow-out has significant employment generation potential, assuming adequate supply of juveniles and economic feed sources. The market opportunity is attractive and the grow-out techniques are proven. Many potential grow-out operators have undergone training through the Sea Forest Plantation/ public sector training initiative of the late 1980s and early 1990s, and many already have much of the equipment and gear required. If the commercial and economic factors are conducive, a large number of potential operators could readily gear up to undertake seasonal cod grow-out at marine sites around the island portion of the Province. | + |
| Stage of Development - Timing to Commercialization | • Cod have been produced in hatcheries and raised to the juvenile stage in Newfoundland and in other jurisdictions. (Neilson, Trinity Bay, early 1900s; Sea Forest Plantation, Placentia Bay, 1990s; NAV, Ocean Sciences Centre, 1999; Norway, 1990s, etc.) | + |
| | • Wild cod juveniles and larger cod have been successfully grown to market size through numerous seasonal cod grow-out initiatives in Newfoundland during the 1980s and 1990s. | + |
| | • However, the intensive production of cod from hatchery through to market has only been effectively demonstrated in Newfoundland on a pilot scale. While there are no apparent constraints to achieving commercial scale for cod aquaculture, it remains to be demonstrated. At least one Newfoundland company is preparing to establish a commercial cod hatchery and grow-out operations. That company has developed broodstock and broodstock holding facilities, has assembled an experienced team, has produced 50,000 cod juveniles in 1999, has the financial resources to lever complementary public investment, and has associated processing, marketing and distribution experience. | - |
| | • If a commercial scale cod hatchery is successfully established, there is evidence that other private investment groups would undertake cod aquaculture initiatives. | + |
| | • Private and public sector (at least two Regional Economic Development Boards) interest has been expressed in developing an intermediary (or nursery) cod operation. This facility would draw juveniles from a hatchery and overwinter the cod. Markets would be either supplying seasonal grow-out operations or full-cycle operations. | + |
| | • Seasonal cod grow-out has arguably already proven to be a commercially viable enterprise. A number of factors have inhibited a larger scale of participation by new entrants. The development of a source of consistent juvenile supply might promote acceleration of new entries. Cost-effective feed and feeding regimes remain potential concerns. | + |

| **Table 3.7: Atlantic Cod - Evaluation Framework** | | |
|---|---|---|
| Assessment | • Development of cod aquaculture is accelerating internationally, driven by strong market demand and depleted supply from wild stocks. Newfoundland is well positioned competitively, at or near the leading edge of cod aquaculture development.<br>• Newfoundland enjoys competitive natural advantages: a suitable marine environment; considerable experience and technical expertise; and well established support infrastructure (OSC, Marine Institute; processing plants and distribution networks).<br>• There is evidence of private sector interest to develop hatchery, marine grow-out (and possibly nursery) initiatives. Development of a consistent supply of juveniles and cost effective feed/feeding regimes could lead to accelerated seasonal grow-out operations. | + |

**Recommendations**

- Cod aquaculture should be considered a medium to high priority for commercial development. Considerable expertise and infrastructure complement conducive natural conditions for cod aquaculture. Seasonal growout is at the pre-commercial stage and warrants support for further development. Although full-cycle aquaculture is in the research and development stages prospects appear bright for development and warrant research and developmental support. The development of full-cycle aquaculture could also greatly strengthen the seasonal growout sector, by providing a consistent source of juveniles for ongrowing to supplement the variable wild supply.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.

### 3.2.2 Giant Scallops

**Introduction**

Scallop aquaculture is a growing and dynamic industry, with world production today totaling approximately 1.3 million tonnes. The industry is dominated by two countries, Japan and China, who account for 98% of world aquaculture production. Canada is a relatively small player in the scallop aquaculture industry, producing annually less than 200 tonnes since the late 1980s.

The development of the industry in Atlantic Canada has been disappointing. In the region, there has been well over a decade of research and pre-commercial development, during which time several industry members have attempted unsuccessfully to establish viable long-term commercial operations. Failures have included high profile attempts such as National Sea Product's subsidiary Fisheries Resource Development Limited, who spent over $2 million of private money and many more millions of public dollars on a research and development operation in Nova Scotia before abandoning the enterprise. Only a very small number of scallop culture operations have been able to survive through the past decade and these operations have remained very small in size.

**Market overview**

For Canadian producers, both of wild and cultured product, the United States is the principal market, taking fully 90% of the production. Through the wild fishery, Canada is the dominant supplier of premium, fresh scallops in the market, but a rather small contributor to the country's frozen scallop market.

In general, the market can be divided into two major segments: for meats only and for whole, shell-on product. The first segment is very large and well established, while the whole scallop segment is small and ill-defined. Demand for giant scallop meats is constrained by supply, which has been adversely affected by diminishing wild harvests. The limited supply coupled with good economic conditions in the United States has provided for excellent price levels. As resource recovery may be delayed for many years, the high prices are expected to continue.

Whole scallops do not constitute a well established or large segment of the market as of now. The prices for the product are however excellent when markets can be found. On average, the whole scallop can fetch twice the price that its meat alone would obtain. Development of this segment, however, is constrained by the short shelf-life of the product, which presents logistical problems, and the lack of a large, consistent supply of the product.

**Development of the Newfoundland Aquaculture Industry.**

The Newfoundland industry developed during the 1980s and 1990s, when three primary industry members were operating. During that time, the industry was focused on research and development, primarily on farm production techniques. Trials on grow-out technology indicated that the preferred technology to use in Newfoundland was the traditional Japanese pearl net.

At first, the industry was supplied by abundant wild spat collections from the waters off the Port au Port Peninsula. During the early 1990s, however, the wild supply of spat declined and attention was turned toward the establishment of a spat hatchery. In 1995, at a cost of $1.3 million, the Newfoundland government opened a scallop hatchery in Belleoram. The facility, which was to form the backbone of the industry, was designed to produce annually 20 million spat. After two years of production levels of 500,000, spat production increased ten-fold in 1998 (with 2 million surviving to marketable spat size), only to decrease again to its former level of 500,000 in 1999.

In 1997, a comprehensive research and development project on scallop aquaculture was funded by the Aquaculture Component of the Economic Renewal Agreement (ACERA) and the Canadian Centre for Fisheries Innovation (CCFI). While the project has been successful in making inroads towards better production technologies under Newfoundland conditions, the effort has not paid off in the expected enhanced industry production. In fact, the industry now appears to be in decline. Following the decline of the Port au Port Development Association's operation, the two remaining industry players have continued to operate. Their output, however, is greatly diminishing: it has decreased from 19 tonnes in 1996 to approximately 1 tonne in 1998.

**SWOT Analysis**

The following table (Table 3.8) summarizes the strengths, weaknesses, opportunities and threats facing the future development of giant scallop aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix D).

**Table 3.8: SWOT Analysis - Giant Scallops**

| Internal | |
|---|---|
| Strengths<br>• Growout technologies are well known and improvements have been made in labour efficiencies.<br>• Hatchery and grow-out infrastructure is in place. | Weaknesses<br>• Despite over 20 years of public and privately funded R&D, a commercial scallop sector has not evolved.<br>• Hatchery production at commercial levels has not been accomplished on a reliable, routine basis. The hatchery is not economically viable at current production levels.<br>• Economic viability of grow-out in Newfoundland has not been established.<br>• The current level of private support for scallop growout is low; neither of the two established farms purchased spat in 1999. |
| External | |
| Opportunities<br>• The market for scallop meats in North America is very strong and prices are at high levels. Prospects for continued high demand and prices appear good.<br>• Cultured product could fill the need left by a declining wild resource.<br>• Culture of other scallop species is a proven, commercial industry in other jurisdictions. | Threats<br>• The market for meats is subject to the performance of the wild fishery. Although unlikely in the near future, a rebound of wild harvest levels could affect price levels.<br>• The market potential for whole scallops is unknown, and significant market development is required.<br>• There is substitution of giant scallops in the market by other species, including other cultured species.<br>• The outside investment community has better opportunities for their dollars in terms of level of risk/return. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.9 below, although giant scallops may be biophysically suited to Newfoundland conditions the culture of these scallops has not developed as a commercial sector. Hatchery production has not reached the stage of being routine, and the current limited growout operations are not planning new investment. Overall, this sector should be considered a low priority for commercial development at this time.

**Table 3.9: Giant Scallops - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperature conditions range from 10°-20°C; survival is possible from -2.0° to 21°+C. Minimum salinity requirement is 20 ppt, generally higher salinity is required for good growth and survival.<br>• In some areas environmental conditions may be suitable. Careful site selection is critical, to avoid areas of high water runoff, extreme summer temperatures, high fouling, predators, and moving pack ice and to find areas of high productivity (food availability).<br>• Potential compatibility with mussel culture sites may exist. | M |
| Production Potential - Biological | • Hatchery production is possible but has not been consistently proven at commercial volumes. Requires further refinement.<br>• Growout techniques have been developed and proven. However, instances of high mortalities have been experienced. Labour efficiencies have been improved. | M |
| Production Potential - Economic | • Hatchery is not viable under current conditions, and needs to produce 10-15 million spat per annum on a reliable basis for viability.<br>• Growout for meats may be marginally viable, and may be improved with sales to the whole live market. Development is constrained by access to a reliable source of spat. Has not been proven viable on a commercial scale. | - |
| Marketing Potential | • Strong markets for meats exists in North America. Prices are at high levels.<br>• Size and potential of the whole scallop market are unknown, although are probably limited to a niche market in the white tablecloth trade. It requires significant development efforts. Geographic dispersal limited by shelf-life. | +<br>- |
| Human Resource Capabilities | • High level of expertise in hatchery and growout techniques is resident in the province. | + |
| Availability of Capital - Private | • Current growers are not planning additional investment.<br>• Potential returns may not be attractive enough to entice new investment. | - |

| Table 3.9: Giant Scallops - Evaluation Framework | | |
|---|---|---|
| Availability of Capital - Public | • Public sector has invested millions of dollars in scallop culture development over many years with very little commercial development in return.<br>• It is supported by Regional Economic Development Board in the Coast of Bays region. Board is also supportive of salmon/steelhead and mussel development, two much higher priorities.<br>• Scallop culture in Atlantic Canada does not have a track record of commercial success - future public sector support is questionable. | - |
| Employment Generation Potential | • Hatchery has potential to generate 4 to 5 full-time seasonal positions.<br>• Farming of scallops still fairly labour intensive at times. Large farm could provide significant full- and part-time labour opportunities. | + |
| Stage of Development - Timing to Commercialization | • Hatchery would require at least 2 to 3 additional years to prove its ability to produce commercial spat numbers on a reliable basis.<br>• Given a reliable supply of spat, farms could be expanded to commercial scale relatively quickly. Both current growers have enough gear for commercial scale development. | -<br>+ |
| Assessment | • Scallop culture has not developed as a commercial activity in Newfoundland. Current growers are not planning commercial expansion. Low hatchery production is also constraining the potential for expansion or new development.<br>• Under current conditions the scallop should not be considered a priority species for commercial development. | - |

**Recommendations**

- This species should be considered a low priority for commercial development at this time. It does not warrant the support of public funding for commercialization.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.
- The hatchery production of scallops remains at a research and development stage and should be a low priority for commercial development in view of the research required.
- Grow-out has been attempted over many years and has not developed as commercially viable enterprises. It should be accorded a low priority for commercial development.
- Future development in hatchery or growout operations must be led by the private sector.

### 3.2.3 Arctic charr

**Introduction**

Researchers have been developing techniques for raising Arctic charr over the last 20 years. Most of the fundamentals of intensive Arctic charr culture have been identified over that time by Canadian, Norwegian and Swedish scientists. In Canada efforts have been concentrated on genetics, physiology and nutrition. Despite these worldwide initiatives, rapid development of Arctic charr culture has not occurred. It is held that the following are holding back development: broodstock development, limited supplies of fast growing juveniles, variable growth and pigmentation, early maturation, intolerance to saltwater and various marketing considerations.

**World Production**

Because there is such a small amount of charr produced internationally, production figures are very difficult to obtain. Total world production, primarily from Norway, Iceland and Canada, is estimated at 1,775 tonnes, between 1,000 and 1,500 tonnes of which comes from Iceland. This total, compared with production levels in 1984 of 50 tonnes, indicates very slow development of this species' culture. Industry members, however, hope for an increase to 20,000 tonnes by 2010.

There are two major strains of charr used in production: a slow growing, smaller Labrador strain and a strain known as Nauyuk charr, which may produce a larger fish in shorter time. Recent efforts with the Nauyuk strain may be promising. Icy Waters International Limited is using a strain known as the Yukon Gold™ strain which the company claims has the potential for good performance and quality characteristics; growing 33% faster than the Labrador strain and exhibiting a bigger terminal growth.

**Markets**

Prices in the marketplace appear to depend on the size of the fish. Smaller charr tend to be linked with the relatively small farmed trout and receive the same prices, while larger charr tend to find themselves in with the salmon, fetching prices in the same range. The example of some suppliers in the market demonstrates that the present pricing limitations can be circumvented. Aquanor of Boston, and Icy Waters are niche-marketing their Arctic charr, and obtaining better prices. Their success in the marketplace appears to be supported by the present balance between quality, demand and supply. Any increase in supply may well upset this situation, lowering prices.

**Species Aquaculture in Newfoundland**

Research and development has been under way for 15 years at significant cost to public funding agencies. Efforts have been made throughout the province, but they have been concentrated on the Great Northern Peninsula. In 1995 the provincial government conducted a review of the Arctic charr industry and found that operations based on the Fraser River strain to produce pan-sized charr in cage culture were not economically viable and should be abandoned. Cage culture was also hampered by Proliferative Kidney disease, PKD, caused by an endemic organism in Newfoundland waters.

In 1997, with support from ACOA and the Strategic Regional Development Agreement (SRDA), the Great Northern Peninsula Development Corporation began construction of a land-based operation using groundwater resources and designed to operate at densities of 100 to 110 kg per cubic metre. An independent evaluation has determined that the facility can only operate at levels of 30 to 40 kg per cubic metre. At these levels, the operation cannot be economically viable. The strain of fish used is also affecting development potential. Research and development on strain selection will be another two to four years before usable results are obtained.

### SWOT Analysis

Table 3.10 summarizes the strengths, weaknesses, opportunities and threats facing the development of Arctic charr aquaculture in Newfoundland, based on a detailed assessment of industry and market conditions and issues facing development (See Appendix E).

**Table 3.10: SWOT Analysis - Arctic Charr**

| Internal | |
|---|---|
| Strengths<br>• Groundwater sources are available, which are biophysically suitable for charr growth<br>• Significant research and operational experience on raising the species resides within the province. | Weaknesses<br>• After 15 years of R&D and pre-commercial development, Arctic charr is still not proven as a commercially viable aquaculture species.<br>• The Fraser River strain performs very poorly.<br>• Usable results from research and development on broodstock are not expected for several years.<br>• Susceptibility to PKD, which appears to be endemic, reduces the potential for pond culture.<br>• The current land-based facility is unable to meet production targets.<br>• Land-based facilities are highly capital intensive and require low labour inputs. |
| **External** | |
| Opportunities<br>• There is potential to position charr as a premium salmonid species through cooperative marketing and targeting high-end consumers with the low volumes of production.<br>• Potential may exist for a joint venture with a private company in utilizing the existing facility for broodstock holding and hatchery operations. | Threats<br>• Competing interests could undercut pricing, tarnish the premium image and reduce the species to commodity status.<br>• Increased production will negatively affect available prices, as new markets have to be found. |

### Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.11, Arctic charr aquaculture has shown a very slow rate of growth over the past 15 years. Significant expenditures have not resulted in the development of a commercial charr industry in the province. Further large expenditures would be required to provide the potential for commercial development. The following analysis indicates that such expenditures are not warranted at this time.

**Table 3.11: Arctic Charr - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Groundwater resources with heat supplementation and recirculation are suitable for culture<br>• Freshwater ponds with depth and temperature profiles required to avoid PKD are not readily available. | +<br>- |

## Table 3.11: Arctic Charr - Evaluation Framework

| | | |
|---|---|---|
| Production Potential - Biological | • Hatchery and growout protocols are known. | + |
| | • The species prefers high stocking densities. | + |
| | • Growth rates are variable among and within strains. | - |
| | • Charr has low tolerance to higher temperatures. | - |
| Production Potential - Economic | • It is not a proven commercial species. | - |
| | • Pond culture of pan-sized charr is uneconomic. | - |
| | • Land-based culture may be economic at a scale of 200 tonnes or more. | + |
| Marketing Potential | • Low volume of product exists in market. | - |
| | • Price varies by size; the lower price for smaller fish is tied to price of trout | - |
| | • Larger fish receive higher prices and can be tied to the price of salmon. | + |
| | • Premium prices can be achieved in upscale market segments. | + |
| Human Resource Capabilities | • Experience with Arctic charr exists in the province. | + |
| | • Highly trained technical personnel for land-based recirculation facilities would be required. | - |
| Availability of Capital - Private | • Prospects for new private-sector investment do not appear promising. | - |
| Availability of Capital - Public | • Significant public funds have been expended in the past with little resulting sustainable commercial development. | - |
| | • Prospects for future public funding are questionable, while a major capital investment is required to bring current facility to the size and capability required for potential economic success. | - |
| | • The existing facility could act as a broodstock holding/development facility and hatchery. This would only be realistic if other entrepreneurs were available to purchase the eggs or fry from the facility. | + |
| Employment Generation Potential | • Land-based facilities have high capital costs, but create few jobs. A 200 tonne facility could potentially run with three to four personnel. | - |
| Stage of Development - Timing to Commercialization | • The quickest potential way to spur development would be to purchase eggs in a joint agreement with a company with an established, proven broodstock. However, to do this, the existing facility would require upgrading, or new growout facilities would have to be developed, all at significant cost. The minimum timeframe would be two years. | - |
| | • Based on continuing use of an underperforming strain of fish and the use of broodstock selection techniques to improve performance, economic growth levels might be reached in four to five years, if ever. | - |

**Table 3.11: Arctic Charr - Evaluation Framework**

| | | |
|---|---|---|
| Assessment | • Arctic charr is not a proven commercial aquaculture species. The total worldwide production is very low and the history of the species in Canada is tainted with many cases of failure and bankruptcy.<br>• The potential may exist through collaborative agreements to develop commercial charr culture in Newfoundland, but a high level of capital investment would be required.<br>• Future development should be based on private sector-led development, backed by a strong, sound business plan and positive corporate track record. | - |

**Recommendations**

- This species should be considered a low priority for commercial development at this time. It does not warrant the support of public funding for commercialization.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.
- Future worldwide developments in Arctic charr culture should be monitored to determine when and if the species becomes established as a sound commercial opportunity. Only then should future development be considered based on strong private sector backing and a sound business plan.
- The only other option warranting current consideration would be the modification of the existing facility to a broodstock holding/development and hatchery operation in conjunction with an established company. This would only be possible with strong commitment from the private sector company and a plan to sell eggs/fingerlings outside the province for the foreseeable future. Development of growout capacity for the hatchery in Newfoundland would be cost- prohibitive at this time and does not have the entrepreneurial backing required.

### 3.2.4 American Eels

**Introduction**
Eels are a seafood product consumed primarily in the Asian marketplaces of Japan and China, and in Europe. Both areas together consume the 250,000 tonnes of eels produced every year by wild fisheries and aquaculture.

The world supply of eels is dominated by the Japanese eel, which makes up 75% of the total amount sold. The North American fishery, for the American eel, is a very small contributor. Traditionally, there has been a small fishery on the American and Canadian east coasts, which has been in decline in the 1990s. In Canada, the catch has declined from 1,000 tonnes in 1991 to less than 500 tonnes in 1997.

**Aquaculture Technology**
Eel aquaculture is everywhere based on the use of elvers (or glass eels) from the wild fishery. Following harvest, they are ongrown in one of two types of operations: either pond culture systems, which are common in Asia or intensive recirculation systems, which are used in northern Europe. The recirculation systems are needed in colder climates, as eels need water temperatures of between 23° and 26° C. In Atlantic Canada, eel aquaculture operations have been established using turn-key technology systems from Europe. Operations include one farm in Nova Scotia, two in New Brunswick and an experimental farm in Newfoundland.

**Market**
Japan and China consume 90% of production. In Europe markets exist in the Netherlands, Denmark and Germany for smoked and fried eels and in southern Europe where demand exists for glass eels. The market has developed in different regions for different product forms and sizes. The primary markets served by European aquaculture and fishing industries include the following: small smoked eels (100 to 150 grams), fetching between $10 and $12 per kilogram in Holland and German; fried eels (160 to 250 grams) which receive prices of approximately $13 per kilogram; large smoked eels (300 to 800 grams), which command prices of $16 to $18 per kilogram; processed eels for Kabayaki production (marinated eel fillets) (160 to 220 grams) and glass eels (4,000 to 5,000 make up one kilogram).

Ninety percent of the production is sold in live form, a substantial amount of which is at the elver size. The average value of imports of all products has increased from $14,000 per tonne to $24,000 per tonne since the mid-1990s.

**Species Aquaculture in Newfoundland**
In Newfoundland, North Atlantic Aquaponics Limited is growing out eels they purchase from local fishermen. As part of the company's plans to establish a 200- tonne commercial facility, it has set up a pilot-scale recirculation system for research and development. To date, the enterprise has been successful in ongrowing limited quantities of eels to commercial size. In 1997, the company paid $50 per kilogram for glass eels from local fishermen. Aquaponics believe they will need between 200 and 600 kg of elvers to produce 200 tonnes of product.

It is possible that the commercial operation would benefit from cheap electricity rates, compared to those in Europe. The company plans to use a turn-key operation they will obtain from a Danish company. They also plan to continue selling wild eels and to investigate the potential for ongrowing yellow eels. Secondary processing may also be developed. The company plans to market in Europe and Asia and develop ethnic markets in Canada and the United States.

## SWOT Analysis

Table 3.12 summarizes the strengths, weaknesses, opportunities and threats facing the development of American eel aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix F).

**Table 3.12: SWOT Analysis - American Eels**

| Internal | |
|---|---|
| Strengths | Weaknesses |
| • Eel aquaculture is a proven, viable industry in Europe and the Far East.<br>• Turn-key specialized recirculation systems are available for eel aquaculture. Technological developments have greatly improved the operating costs of these operations. | • The operation is a highly capital intensive development with little direct job creation.<br>• Information on American eel performance/ protocols is lacking, as compared to that on European eel.<br>• Economics/cost of production data lacking on commercial American eel production.<br>• Transportation costs are high to major markets and logistics can be difficult.<br>• The support structure is weak for industry in the region: fish health, technical and biological knowledge is not readily available.<br>• Potential exists for quality problems in freshwater systems.<br>• Seedstock supply depends on the wild harvest and price fluctuates greatly for glass eels.<br>• A large scale is needed to provide the economies of scale required for viability. |
| External | |
| Opportunities | Threats |
| • Markets in Europe and the Far East have generally been very strong in recent years. The Far Eastern economies appear to be rebounding from economic crisis.<br>• The potential exists for development of markets among ethnic populations in large urban centers in Canada and the United States.<br>• The weakness of European and Asian wild harvests opened opportunities for American eels. | • The market's strength has attracted new development in the industry in Europe, increasing the competitive supply.<br>• There is potential for a rebound of European and Asian stocks.<br>• The supply of elvers is unknown.<br>• Access to private sector financing is required.<br>• The environmental impact of removing large quantities of elvers from rivers is unknown. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented below in Table 3.13, eel aquaculture is an established, proven industry which may have the potential to be viable in Newfoundland. Questions remain to be answered regarding the performance and profitability of American eels in commercial culture. Success will be greatly affected by the use of newer recirculating technology which will lower operating costs and access to experienced biological and technical resources. With the size of the capital investment required there will not be much room for problems or learning curves. As with all businesses, the managerial and financial strength of the proponents will be a determining factor in success. According to European aquaculture specialist Dr. Bent Urup, "There could be a future in eel farming in Canada. Canadian farmers will probably not be competitive on the European market, but they will have advantages on the ethnic markets in North America, and potentially on export markets in Asia. The Canadian farmers would in some regions like Newfoundland have advantages in the easy access to freshwater and seawater on the same location, which by combining these supplies, will make it possible to make a superior quality product, whereas most European farmers are restricted to use freshwater only, and further do not use a technology applicable for seawater. Further a recirculated eel farm will potentially heat itself up, but a chilling source is typically then needed during summer to chill the system down. In Canada it will often be possible to find a location with a cold water source all year around, even of seawater. An eel-farm can be very automated, and labour costs can be minimised. Canada could further be self supplying on glass eels/elvers. Eel farming is a kind of business which is also suitable for one or two person operation."

**Table 3.13: American Eels - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperatures for the species range between 23°and 26°C. Heated recirculation systems are needed in Newfoundland, as in northern Europe where a viable industry exists.<br>• Access to fresh and saltwater at the same site could be advantageous to product quality. | -<br>+ |
| Production Potential - Biological | • Eel aquaculture is proven in Europe and the potential exists to transfer techniques from there.<br>• There may be differences between American and European eels that could affect performance and viability.<br>• Small-scale trials show promising growth results at less than ideal conditions. | +<br>-<br>+ |
| Production Potential - Economic | • A large-scale development is needed to be economically viable.<br>• With high capital costs, Internal Rate of Return (IRR) potential is unknown.<br>• The proponent's plans to continue marketing wild eels could provide much needed cash flow support. | |
| Marketing Potential | • Markets are strong in Europe and Asia.<br>• New capacity additions in Europe may make it difficult to compete in this market.<br>• The potential exists to develop North American ethnic markets. | + |
| Human Resource Capabilities | • The region lacks knowledge of eel aquaculture.<br>• Farmers may be able to access experienced biological and technical support from Europe. | -<br>+ |
| Availability of Capital - Private | • New equity investment is needed.<br>• Investment prospecting may be required. | U |

**Table 3.13: American Eels - Evaluation Framework**

| | | |
|---|---|---|
| Availability of Capital - Public | • Eel farming is supported by the Regional Economic Development Board, and<br>• Has received support in the past from HRDC<br>• Potential support should be based on a sound business plan that illustrates managerial, technical and financial strength. | U |
| Employment Generation Potential | • Land-based facilities are high in capital costs, but create few jobs. A 200 tonne facility could potentially operate with three persons.<br>• There is potential to support large numbers in the eel fishery: at $200/kg for glass eels, the fishery could provide $40,000 to $120,000 in revenues to over 40 fishermen during a short period . | - |
| Stage of Development - Timing to Commercialization | • Based on access to financing (public and private) a farm could be developed relatively quickly, within two years. | + |
| Assessment | • The potential may exist for a limited number of commercial developments, based on the capital required.<br>• The proponents' strength in managerial, technical and financial areas will be key to success.<br>• Remaining questions regarding American eel performance and economics must be addressed. | +<br>-|

**Recommendations**

- This species has a reasonable chance for commercial development. Each proposed farm will have to be evaluated individually, particularly with respect to the proponent's managerial, technical and financial strength.
- There is no need to reinvent the wheel. Future development may take advantage of existing technology and biological and technical expertise available from Europe. During the early stages of development, full-time employment of expertise may be warranted to ensure the system works properly and to provide hands-on training.
- Some questions remain regarding the performance and potential viability of American eel culture. Further research required to address outstanding issues. Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.
- A high level of private capital investment is required to support the development of a costly, land-based recirculation system.
- Because of large capital costs, the number of potential operations may be limited. Eel farming does not offer the potential for large numbers of employees, and, as such, it should not be a top priority for commercial development, but projects should be evaluated on a case by case basis.

### 3.2.5 Yellowtail Flounder

**Introduction**

The yellowtail flounder is a flatfish that is not produced in commercial aquaculture. Fished traditionally by trawlers offshore, it was one of the groundfish species that was placed under moratorium in 1994, seriously affecting the company that held much of the large-vessel yellowtail flounder quota, Fishery Products International (FPI). The moratorium was lifted and the company's quota reinstated in 1998. The quota stands at a level of 5,850 tonnes in 1999.

Research on the aquaculture of yellowtail flounder has been carried out during the latter half of this decade at the Ocean Sciences Centre and the Huntsman Marine Science Centre (HMSC).

**Markets**

This fish is primarily sold to the institutional market, where it is in demand in fillet form. FPI has niche-marketed its catch in the American institutional market quite successfully. The species provides a mid-value product, priced below the levels for halibut and witch flounder. The price of yellowtail fillets has generally held between US$4.40 and $4.70 per pound during the 1990s. At this price level, the whole fish value would be less than US$1.30 per pound.

**Species Aquaculture in Newfoundland**

Based on a positive assessment presented in a preliminary analysis of the aquaculture potential of various small flatfish species by Dr. Greg Goff, the Canadian Centre for Fisheries Innovation and Fishery Products International began a research and development initiative on the species during the year that the moratorium on the species was begun. The yellowtail was considered the most promising of the small flatfish for aquaculture success. The research, which was carried out at the Ocean Sciences Centre and the Huntsman Marine Science Centre, focused on broodstock development and manipulation, egg incubation and larval rearing. Between 1994 and 1996 successes were recorded in each of these areas at the Ocean Sciences Centre. The growth rates of juveniles have been disappointingly slow, however. Continued growth trials are in progress at the OSC and a comparative trial of different growout technologies is being undertaken at the OSC and on a farm site in Trinity Bay.

**SWOT Analysis**

Table 3.14 summarizes the strengths, weaknesses, opportunities and threats facing the development of yellowtail flounder aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix G).

**Table 3.14: SWOT Analysis - Yellowtail flounder**

| Internal | |
|---|---|
| Strengths<br>• Newfoundland is leading R&D on this species.<br>• The production protocols for juveniles are established and routine. | Weaknesses<br>• Juveniles exhibit very slow growth rates.<br>• The species has a bi-modal size distribution<br>• There is risk of early maturation.<br>• The species is susceptible to disease.<br>• Broodstock development is required.<br>• Optimal growout conditions are only possible in Newfoundland through capital intensive land-based systems.<br>• The economic viability of yellowtail aquaculture is highly questionable. |
| External | |
| Opportunities<br>• As the primary producer of wild yellowtail, the private sector partner offered ready processing ability and market access.<br>• Control on quality and production provided through aquaculture offers a potential opportunity for premium pricing in niche markets | Threats<br>• Private sector support may be difficult to access.<br>• The market price is low compared to those of premium flatfish species; there is low market supply, and significant aquaculture development (over 1,000 tonnes) could negatively affect price. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in the table below, Table 3.15, it is concluded that, at present, yellowtail flounder should be a low-priority species for development in Newfoundland. The following factors support this view: the questionable economic viability of yellowtail flounder aquaculture; its requirement for high capital investments to generate a small number of jobs; the unknown level of future commitment by the private sector, and the fact that yellowtail flounder is not a premium market species.

**Table 3.15: Yellowtail flounder - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperatures for the species are between 10° and 12°C, but the fish can survive the low/high temperature extremes of Newfoundland waters; it is best suited to land-based culture. | +<br>- |
| Production Potential - Biological | • Juvenile production is proven.<br>• Ongrowing is possible, but marked by very slow growth rates. | +<br>- |
| Production Potential - Economic | • This is not an economic proposition at current slow growth rates and low market prices. | - |
| Marketing Potential | • Yellowtail is not a premium flatfish species, but niche markets might be found. | - |

**Table 3.15: Yellowtail flounder - Evaluation Framework**

| | | |
|---|---|---|
| Human Resource Capabilities | • Trained R&D personnel with species experience exist at the OSC. | + |
| Availability of Capital - Private | • Future level of private sector commitment is unknown. | U |
| Availability of Capital - Public | • Future support is dependent upon industrial support. | - |
| Employment Generation Potential | • Land-based facilities are high in capital costs, but create few jobs. | - |
| Stage of Development - Timing to Commercialization | • Further R&D is required to determine the commercial viability, and a minimum of two years is needed for evaluation prior to commercial development. | - |
| Assessment | • The aquaculture of yellowtail flounder has questionable economic potential, and is not considered a priority for development. | - |

**Recommendations**

- This species should be considered a low priority for development. It does not warrant the support of public funding for commercialization.
- Additional R&D efforts should be limited and small-scale, focused on determining whether growth can be improved to economic levels. The ability to produce juveniles on a pilot-scale basis has been proven and does not require duplication.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.

### 3.2.6 Sea Urchins

Sea urchin roe is a product primarily sold in Japan and other Asian countries. There is also a small market for the roe in France, which is supplied by domestic and other European fisheries. The roe, which is called "uni" in Japan, is considered a premium product in that country, where very specific tastes demand a product with a particular appearance, texture, taste and colour.

**Markets**

In the 1990s, prices for the best uni have been generally attractive, (even reaching $200 per kilogram in 1996 during a resource crisis in Japan). The market and its prices, however, are subject to fluctuations, with downturns occurring simultaneously with economic downturns, product dumping, change of season and other factors. Weather disruptions such as typhoons can cause product shortages, and hikes in prices.

**Supply**

Wild fisheries have been the only source of sea urchins to date. With resource depletion in many areas, including Japan, however, attention has turned to the culture of the sea urchin. Research efforts are under way in a few countries on two different goals: ways to ranch mature wild sea urchins to improve their roe yield or quality, and ways to grow them in full-aquaculture systems from egg to market size. Japan, France and Atlantic Canada are the primary areas where this research is proceeding.

**Development of the Newfoundland Aquaculture Industry**

In Newfoundland, research under way since 1994 on sea urchins has been almost entirely devoted to on-growing the animals to enhance their roe's quality and size. Experimental trials early on demonstrated that the roe of the animal could be substantially increased and its quality maintained through ranching. The trials showed that roe could increase from 4% to 20% in 10 weeks of on-growing. Trials on the potential for land-based growout have been undertaken by two additional groups: Greens Seafoods and the Gambo-Indian Bay Development Association. Green Seafoods of Winterton became interested in the trials and, with Memorial University and the Marine Institute, began pilot-scale trials in 1995. Over the years, experiments seem to have ironed out the problems that were causing high mortalities and low yields. More research is being undertaken to improve roe quality, with recent reports of promising results using an artificial diet. Commercial viability of on-growing urchins has still not been determined, however. In addition, the Gambo-Indian Bay Development Association have launched a series of experiments in their research facility on the best tank designs, diets, stocking densities, water flows and oxygen requirements for sea urchins.

Trials have also been completed by Memorial University researchers and private sector entrepreneurs on the potential for seabed growout. Trials were undertaken in Placentia Bay in 1997 at the New Ocean Enterprises Ltd. sea-bed site. "In order to determine the potential for this activity a pilot-scale project was undertaken to farm approximately 10,000 pounds of urchins. The results from the trial have been very encouraging. Although the feeding of urchins did not start until October, a time when water temperatures are starting to decrease, the results achieved in terms of gonad yield and quality improvements were substantial. Results from the shipment of live whole urchins to Tokyo reached gonad yields as high as 18%, with 15% AB, and obtained a premium price of $4.87 Cdn/lb" (Bridger: 1998, p. 1). Despite these encouraging results there has been no follow-up on this research.

In the area of full-scale aquaculture, Marine Institute researcher Dr. Jay Parsons, with a team of students, has led a few small-scale research projects. Researchers in the province are keeping in close touch with other Canadian researchers on developments in this area.

### SWOT Analysis

Table 3.16 summarizes the strengths, weaknesses, opportunities and threats facing the development of sea urchin culture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix H).

**Table 3.16: SWOT Analysis - Sea Urchins**

| Internal | |
|---|---|
| Strengths<br>• Significant progress has been made on roe enhancement in land-based and bottom culture.<br>• Bottom culture trials have shown positive results with respect to economic potential. | Weaknesses<br>• The protocols for hatchery and growout operations in full-cycle culture are largely unknown.<br>• A commercially formulated feed that provides high quality roe is not yet available.<br>• Roe enhancement potential is tied directly to health of the wild resource.<br>• Economic viability is still unproven. Prospects for bottom culture appear positive. |
| External | |
| Opportunities<br>• High prices are paid for high quality urchin roe.<br>• Aquaculture allows for targeting the market at times of low supply.<br>• A decline in wild harvests worldwide creates opportunities for full-cycle culture to fill the demand.<br>• Potential to increase the roe yield and value of non-commercial wild urchin beds. | Threats<br>• One dominant market player exists: Japan. Industry is tied closely to developments and economic conditions in this market.<br>• Market price is highly variable, both on a daily and seasonal basis.<br>• Russians industry dumps urchins in market at low prices. |

### Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.17, sea urchin roe enhancement may have potential for development as a viable industry. Pilot-scale bottom culture trials have provided positive results. For land-based culture a number of questions or unknowns remain which hinder commercial development. Given the current uncertain status of the wild sea urchin resource and the additional research and development required to determine commercial viability, land-based sea urchin roe enhancement should not be considered a high commercial priority. However, the commercial potential for bottom culture does appear promising and may warrant targeted support. Full-cycle aquaculture requires extensive research and development activity for development and should not be given priority status.

## Table 3.17: Sea Urchins - Evaluation Framework

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • The species can survive a wide range of temperatures and conditions, but is susceptible to freshwater pulses. It can be suited for land-based or bottom culture. | + |
| Production Potential - Biological | • Full-cycle aquaculture.- Proper protocols are unknown.<br>• Roe enhancement operations- The protocols are generally known. | -<br>+ |
| Production Potential - Economic | • Full-cycle aquaculture - The economic potential is still unknown.<br>• Roe Enhancement - The economic viability has not been proven on a commercial scale.<br>*Bottom culture* - positive potential.<br>*Land-Based* - potential unknown/unproven. | -<br>+<br>- |
| Marketing Potential | • The industry depends on one market, with highly variable prices.<br>• There is potential for very high prices with the right combination of product and market conditions. | -<br>+ |
| Human Resource Capabilities | • Trained R&D personnel with species experience exist in the province in the public and private sector. | + |
| Availability of Capital - Private | • The private-sector partners have supported the R&D activities, but have not indicated plans to move forward with commercial development. | - |
| Availability of Capital - Public | • Significant amounts of public funds have been expended to date on R&D and further R&D funds are required to determine the commercial potential.<br>• Scale-up of bottom culture to commercial levels may warrant targeted support. | + |
| Employment Generation Potential | • To be viable, the operation cannot be a major job creator, whether land-based or bottom culture. | - |
| Stage of Development - Timing to Commercialization | • Full-Cycle - There is a great deal of R&D activity required: three to five years is needed for development.<br>• Roe enhancement - Further R&D is required to determine commercial viability.<br>*Bottom Culture* - Potential may exist for early commercialization of bottom culture sites at suitable locations.<br>*Land-based* - A minimum of two to three years will be needed for evaluation prior to commercial development of land-based units. | -<br>+<br>- |
| Assessment | • The economic potential has still not been proven on a commercial scale.<br>• Sea urchins should not be a high priority for commercial development. Consideration for bottom culture development may be warranted.<br>• R&D efforts should continue to develop commercial feeds and determine the potential for land-based culture. | M |

## Recommendations

- Recommendations on development are mixed, depending on the type of culture:

  *Full-cycle culture* - low priority for development, does not warrant the support of public funding for commercialization.

  *Land-based roe enhancement* - low priority for development, does not warrant the support of public funding for commercialization. Continued R&D may improve commercial prospects.

  *Bottom culture roe enhancement* - medium priority for development, may warrant the support of public funding for commercialization.
- Additional research and development efforts should focus solely on answering outstanding questions directly related to commercial viability.
- Relevant agencies should provide funding support for continued applied R&D efforts only if backed by continued industrial support, preferably through collaborative efforts by existing players.

## 3.3 RESEARCH SPECIES

### 3.3.1 Atlantic halibut

**Introduction**

The development of halibut aquaculture began in the 1980s in Norway. Since that time several other countries, including Iceland, Scotland and Canada, have become involved in halibut research and development, and pre-commercial development activities. The first sale of cultured halibut occurred in 1993, and worldwide production has slowly increased since then to a projected level of 450 tonnes in 1999, of which around 400 tonnes will come from Norway.

**The State of Aquaculture Development Worldwide**

To date, commercial halibut aquaculture has been held back by the inability to produce large numbers of juveniles consistently. It is believed, however, that this problem will soon be a thing of the past. Today, juvenile production in Europe stands at around 800,000 while in Canada, production numbers are lower, totalling 40,000 to 50,000. This level of worldwide juvenile production should lead to the production of between 3,000 and 4,000 tonnes of market fish in three to five years, depending on the growout technology employed. Thanks in large part to the anticipated improvements in juvenile survival, it is expected that production will increase dramatically around 2010, totalling between 10,000 and 13,000 tonnes yearly.

**Aquaculture Technologies**

Varying technologies are in use for the production of halibut juveniles and their subsequent on-growing. To get the fish through first feeding, the different companies involved in halibut aquaculture are working with different technologies. It is still not possible to see which technology is the superior one. The semi-extensive/semi-intensive technology used primarily by the Norwegian industry involves feeding larvae with a mixture of Artemia and wild-caught copepods. The copepods fill the nutritional needs of the larvae, preventing deformities and malpigmentation but they can act as intermediary hosts for parasites and infectious agents that are pathogenic to the larvae. They are not always available in the wild, either.

In intensive culture, larvae are fed only cultured artemia and rotifers. This technology is causing significant problems for growers everywhere at the moment. There is generally low survival through the first feeding stage, as low as 3% to 5%, and fish tend to exhibit a higher instance of malpigmentation and deformities, related to an inadequate nutritional balance.

The cultured copepod system centres around the controlled culturing of calanoide copepods, which provide the same nutritional advantages of wild copepods without the risks of short supply, parasites and infectious agents. This technology is not suited to small-scale pilot production and therefore requires a commitment to large-scale development.

The available ongrowing technologies also carry with them both benefits and drawbacks. The less capital-intensive sea cage system has had varying levels of success due to problems in accommodating the halibut's preference for rigid bottoms to lie on. Predation, disease and temperature fluctuations are also challenges faced in using this system. Land-based flow-through systems provide better FCRs, better disease control and low labour costs. The halibut's penchant for lying on rigid bottoms is accommodated with the easy insertion of shelving. These systems are, however, more capital-intensive, they have higher energy costs and they are not suited to temperature control.

Land-based recirculating systems provide the highest level of control. Energy costs may be less than flow-through systems and labour requirements are low. The downside of this technology lies principally in its high capital costs. As well, energy costs can be high if chilling is needed.

### Wild Fishery

Total worldwide production of Atlantic halibut is quite low. It has dropped from over 8,000 tonnes in 1986 to less than 3,700 tonnes in 1995. In recent years, it has rebounded somewhat and reached levels between 4,000 and 5,000 tonnes.

### Markets

Atlantic Halibut is considered to be a premium whitefish species. Primary markets are located in northeastern North America and western Europe. Prices in those world markets have risen with the decline in worldwide supply from the wild fishery. Unfortunately this does not necessarily mean that cultured halibut will also enjoy strong prices. Given the low volumes of Atlantic halibut captured recently, the development of Atlantic halibut aquaculture could have a direct and negative impact on available market prices. The growout of the approximately 800,000 juveniles produced in 1998 and again in 1999 could result in 4,000 to 5,000 tonnes of product in three to five years. This production level would equal today's total worldwide catch and could have a serious impact on market prices. However, in the near future, with the current decline in the availability of white flesh fish generally, this category is expected to demonstrate strong market prices for top-quality fish. The effects of the larger volumes of halibut may be somewhat softened as a result.

### Species Aquaculture in Newfoundland

Research on the cultivation of Atlantic halibut in Newfoundland began in the early 1990s at Memorial University's Ocean Sciences Centre (OSC). Early research was limited by a lack of necessary technology, and consisted of the collection and domestication of a small number of broodstock and bench-top scale trials on egg incubation and larval rearing.

In 1996 the Aquaculture Component of the Economic Renewal Agreement (ACERA) and the Canadian Centre for Fisheries Innovation (CCFI) approved funding for a research and development initiative on halibut aquaculture. The project included capital investment in the development of a purpose-built halibut hatchery at the OSC and a halibut technology transfer initiative from Norway to the OSC. In the first year, weaning of juveniles onto dry food was accomplished with a survival rate of close to 75%. In the end a total of 1,500 weaned halibut juveniles survived.

In 1998 results were worse despite good larval production. Juveniles that survived through first-feeding totalled less than 300. It is believed that the high mortality rate was primarily the result of live food quality, bacterial loading and water quality problems. The following year, 1999, was similar to 1998.

In the meantime, halibut aquaculture has attracted the attention of local industry and two Newfoundland companies have committed resources to its development.

## SWOT Analysis

Table 3.18 summarizes the strengths, weaknesses, opportunities and threats facing the development of Atlantic halibut aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix I).

**Table 3.18: SWOT Analysis - Atlantic Halibut**

| Internal | |
|---|---|
| Strengths<br>• The necessary infrastructure is in place to support halibut R&D.<br>• There is private sector support for halibut development.<br>• There is good success in survival rates through the silo stage.<br>• Successful intensive culture techniques have been developed elsewhere.<br>• A base of highly trained human resource talent exists in halibut culture techniques.<br>• Juvenile growth rates are high.<br>• A domesticated broodstock is in place. | Weaknesses<br>• Newfoundland R&D has not been successful in achieving high survival rates through first feeding.<br>• Males mature at a small size (2-3 kg). The size is suitable for market but it commands lower prices than the larger product from females .<br>• The fish are highly susceptible to infection during the early stages. The hygiene and water quality required for halibut health has not been achieved at the R&D facilities.<br>• Additional broodstock development is required to enable photoperiod manipulation and the establishment of out-of-season spawning.<br>• Optimal growout conditions are possible in Newfoundland through capital intensive land-based systems.<br>• Economic viability is unknown but questionable under current conditions. |
| External | |
| Opportunities<br>• Atlantic halibut is established as a premium white flesh fish in the major markets of northeast North America and western Europe.<br>• Aquaculture can meet the market's need for consistency in supply, which should create market opportunities. | Threats<br>• The current supply of Atlantic halibut worldwide is low, at 4,000-5,000 tonnes, and prices fluctuate widely with supply availability. Only a modest level of aquaculture production will be required to place downward pressures on prices. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in the table below, Table 3.19, halibut is a species that will require very large investments for commercial development. "Canada seems to be a natural place to grow halibut. Being the biggest nation within the halibut fishery in the past and with easy access to the North American market, Canada should be in a good position for selling the produced halibut. Cold waters is an advantage, especially if recycled production units are considered. Few places have as good natural conditions as Canada for the production of halibut" (Urup: 1999, p. 10).

At present, the species is considered very high risk and the economics have not been proven. Although significant opportunities exist in the premium white flesh fish market, the development of a commercial halibut culture industry could affect prices at a low level of production. Given these factors, Atlantic halibut should not be considered as a high priority for current commercial development.

**Table 3.19: Atlantic Halibut - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperature conditions for growth are between 9° and 12°C, but halibut can survive in the -0.7° to 14°C range. Therefore, high summer temperatures must be avoided in broodstock holding and growout facilities.<br>• The species does not grow at less than 4°C; therefore, cage culture in Newfoundland would result in long periods of no growth. The species is therefore best suited to land-based culture in Newfoundland. | M |
| Production Potential - Biological | • Bottlenecks in juvenile production are being overcome in other jurisdictions.<br>• There is good growth performance and survival from the juvenile stage to market.<br>• Sexual maturation of males occurs before reaching premium market size. | +<br>+<br>- |
| Production Potential - Economic | • Hatchery and growout operations have not been proven to be economically viable. High capital costs of the land-based growout technology dampen potential returns. The production of large volumes through culture could have a serious impact on market prices and viability. | U |
| Marketing Potential | • Atlantic halibut is a premium white flesh product, receiving a premium price in the marketplace. It enjoys a very good image in the market.<br>• An opportunity exists to expand the market with consistent volumes of product.<br>• There are very low volumes of market supply through wild production, and prices are sensitive to supply. Increased volumes of halibut from aquaculture would place downward pressures on prices. | +<br>+<br>- |
| Human Resource Capabilities | • Trained R&D personnel with species experience reside in the public and private sector. | + |
| Availability of Capital - Private | • The development of commercial halibut culture is highly capital intensive. Two local private sector companies are involved. Investment required will limit potential participants. | M |
| Availability of Capital - Public | • The public sector has been very supportive of R&D efforts and infrastructure development.<br>• Future support is dependent on private sector involvement and strength and the species commercial potential. | M |
| Employment Generation Potential | • Land-based facilities are high in capital costs, but create few jobs. | - |

**Table 3.19: Atlantic Halibut - Evaluation Framework**

| | | |
|---|---|---|
| Stage of Development - Timing to Commercialization | • Additional broodstock development is required.<br>• Techniques for intensive culture have to be proven.<br>• Growout facilities have to be constructed.<br>• There is a minimum of three to five years prior to commercial sales. | - |
| Assessment | • This would be a high capital cost, high-risk venture. The economics are unproven and considerable development will still be required to develop commercial culture in the province. Development will have to be primarily private-sector driven and there is limited opportunity for entrants due to the high capital requirements | - |

**Recommendations**

- Halibut aquaculture development remains at the research and development stage and should be considered a low priority for commercial development. The future support of public sector commercial funding agencies should only occur based on the involvement of private sector developers with the financial, managerial and technical competence required to move forward such a large scale, high-risk venture and on demonstrable proof that halibut culture can be economically viable.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support. Priorities for research include improvements in juvenile production and research on the photoperiod manipulation of broodstock.
- The gathering of industry and market intelligence is required to keep up-to-date on industry developments and breakthroughs, the commercial success of other industry players, and the impacts of farmed halibut production on market prices. This information can be used to assist in periodic reevaluations of the species status.

### 3.3.2 Wolffish

**Introduction**

The wolffish is not an important commercial species in North American fisheries, being caught principally as a by-catch in other fisheries. It is considered a low-value, "trash" species to the industry on this side of the Atlantic. European fishermen are generally more interested in the species. Icelandic fisheries for the wolffish totaled 11,700 tonnes in 1997. Norway also has a significant fisheries effort directed toward the species.

Wolffish aquaculture is being led worldwide by one company, Akvaplan-niva of Norway. The company has begun development of production methods and technologies for the culture of the spotted wolffish. Its staff have completed projects on collecting broodstock, fertilization, incubation, start-feeding and fish fry production. Their ongrowing trials have been rewarded with high growth rates and low mortality rates at low temperatures. Akvaplan-niva is also working on market research and health issues.

While there has been no commercial or pre-commercial culture of the species in North America, Newfoundland's Memorial University has been involved in experimental research on the species for five years. Other research trials have begun in Quebec recently and interest in R&D has been expressed in New Brunswick's Huntman Marine Science Centre and the Quebec Department of Fisheries and Aquaculture.

**Market**

This species is not widely sold in the United States. In 1998, the country bought approximately 1,000 tonnes of imported and domestic product. The Canadian market is similar. Atlantic Canadian fishermen in 1997 sold 854 tonnes worth just $332,000, reflecting an average price of $0.39 per kilogram.

In Europe, the wolffish is not a high-price species, but it does earn considerably more for its fishermen, at a 1998 price of between $4.80 and $6.70 per kilogram. These relatively low prices do not reflect the high-quality characteristics of the fish's flesh, however. Commentators often note the pearly white, sweet, firm flesh which is similar to that of cod, the easy effort required to remove its bones and its versatility in cooking.

**Species Aquaculture in Newfoundland**

Newfoundland researchers at the Wesleyville Hatchery, the Marine Institute and the Ocean Sciences Centre have worked on striped wolffish aquaculture for several years. Considerable success has been achieved in the production of juveniles, with post-hatch survivals reaching between 80% and 90%. Juvenile growth rates obtained have been similar to those reported in Norway.

Because of better results reported for spotted wolffish in Norway, collections of that species have been made in Newfoundland in an attempt to establish a broodstock and begin research and development. Collecting has been difficult, with the entire first catch succumbing to high water temperatures and the second collection suffering from high mortalities.

Discussions with Akvaplan-niva on the possibility of collaboration with Newfoundland researchers have been met with interest. Marketing research is now under way in an effort to determine the potential for marketing in North America.

### SWOT Analysis

The table below, Table 3.20, summarizes the strengths, weaknesses, opportunities and threats facing the development of wolffish aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix J).

**Table 3.20: SWOT Analysis - Wolffish**

| Internal | |
|---|---|
| Strengths<br>• These fish are highly developed and hardy animals at hatch, and they can be fed directly on formulated feed with minimal [illegible] feed requirements.<br>• They are very [illegible] to land-based culture, can be grown at [illegible] of 50-85 kg/m^2 or higher.<br>• They grow well at low temperatures, optimum temperatures being in the 4°to 8° C range.<br>• The product is a pleasant, white flesh fillet. | Weaknesses<br>• Production protocols need to be transferred or developed for spotted wolffish.<br>• Broodstock development and technology for egg fertilization is available in Norway but has not yet been transferred to Newfoundland.<br>• Optimal growout conditions are possible in Newfoundland only through capital-intensive land-based systems<br>• The economic viability of this species' aquaculture is highly questionable at current North American market prices. |
| External | |
| Opportunities<br>• Wolffish aquaculture would offer the opportunity to develop a white flesh product for a large market demanding premium white flesh products.<br>• Control on quality and production provided through aquaculture would create an opportunity for premium pricing in niche markets. | Threats<br>• No industrial partner exists for developing this product, which would require a large investment in market development before there would be any chance of success.<br>• The wild wolffish product is considered in North America as "trash fish," fetching very low prices. |

### Evaluation Framework

The standard species evaluation framework presented in the table below, Table 3.21, indicates that, although wolffish may be well suited to land-based culture in our cold ocean environment, the primary impediments to developing an industry are the low market value of wild wolffish in North America and the lack of a strong industrial partner to back the required market development and positioning, as well as the land-based capital requirements.

**Table 3.21: Wolffish - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperature conditions are in the range of 4°to 8°C., which makes it a potential candidate for Newfoundland's cold ocean climate. The species is best suited to land-based culture. | + |

**Table 3.21: Wolffish - Evaluation Framework**

| | | |
|---|---|---|
| Production Potential - Biological | • Technology transfer or the refinement of fertilization techniques is needed.<br>• The production of juvenile spotted wolffish has not been tried.<br>• Juvenile production protocols developed for striped wolffish should be transferable.<br>• The requirements for on-growing are unknown; the species appears to exhibit reasonable growth at high stocking densities and low temperatures. | M |
| Production Potential - Economic | • It is not considered to be economically promising at current low market prices. | - |
| Marketing Potential | • The product has favorable intrinsic characteristics for the premium white flesh market.<br>• It requires extensive market development to position it as a premium white flesh product, which is a very expensive process. | +<br>- |
| Human Resource Capabilities | • Trained R&D personnel with species experience are resident at the Marine Institute and the OSC. | + |
| Availability of Capital - Private | • Any development needs a partner with financial and market strengths; no such partner exists at the moment. | - |
| Availability of Capital - Public | • Future research agency support depends on industrial support. | - |
| Employment Generation Potential | • Land-based facilities are high in capital costs, and create few jobs. | - |
| Stage of Development - Timing to Commercialization | • Further R&D is required to develop/refine production protocols for spotted wolffish and to undertake market research and development; a minimum of three to five years is needed for evaluation prior to commercial development. | - |
| Assessment | • This has questionable economic potential, given current market conditions. Therefore the species is not a priority for development. | - |

**Recommendations**

- This species should be considered a low priority for development. It does not warrant the support of public funding for commercialization.
- Species development requires a major industrial sponsor, with the required managerial, financial and marketing capabilities to support an expensive and time-consuming development track.
- Future R&D and any commercialization efforts should include consideration of a collaboration with Akvaplan-niva for the technology transfer of egg fertilization techniques and for market research activities.
- Relevant agencies should provide funding support for continued applied R&D, only if backed by industrial support.

### 3.3.3 Witch Flounder

**Introduction**

The witch flounder is fished and marketed in eastern Canada and the northeastern United States. Found in Canadian waters at depths of 105 to 400 metres, the fish is very slow in growth, compared to other flatfish (American plaice and yellowtail founder). It does not enter the fishery until age 9 and is only fully exploited at the age of 13 years.

**Markets**

The fish is a premium flatfish, the meat of which is considered to be of high quality in flavour and texture. It is a high-value fish, which fetches prices equal to, or greater than, Atlantic halibut in the fresh fish market. Prices per pound vary with size; the larger the fish, the higher the price, with returns sometimes exceeding US$5.00 per pound.

**Species Aquaculture in Newfoundland**

This species was originally considered to be too technically difficult to raise as an aquaculture species. However, the successful production of witch flounder juveniles in research trials at the University of New Hampshire (UNH) and the species' high market price provided the incentive to investigate the species' potential for aquaculture in Newfoundland. A research project began through a collaborative arrangement between the UNH and the Ocean Sciences Centre in 1997.

The results from the trials to date have been mixed. Egg production has been very difficult. In 1999 none of the broodstock that were collected spawned. Enough eggs and sperm were collected from the wild in 1997 and 1998, however, to study the larvae. While the survival rate of the fish through metamorphosis has been high, growth after settlement on the bottom has been very slow. As work on the juvenile stage has not started yet, no conclusion can be drawn on the juvenile growth rates. Nevertheless, juveniles at two years of age weigh on average only 40.5 grams.

**SWOT Analysis**

Table 3.22 summarizes the strengths, weaknesses, opportunities and threats facing the development of witch flounder aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix K)

**Table 3.22: SWOT Analysis - Witch flounder**

| Internal | |
|---|---|
| Strengths<br>• Newfoundland is one of the leaders in R&D.<br>• The potential appears good to obtain high survival rates through metamorphosis. | Weaknesses<br>• Optimal production protocols are unknown.<br>• Growth rates are extremely slow.<br>• The species has bi-modal size distribution.<br>• There is a potential risk of early maturation.<br>• Broodstock development is required.<br>• Optimal growout conditions are only possible in Newfoundland through capital intensive land-based systems.<br>• Economic viability is highly questionable. |

**Table 3.22: SWOT Analysis - Witch flounder**

| External | |
|---|---|
| Opportunities<br>• It is a high-price species.<br>• Processing sector offers a ready processing ability and market access.<br>• Control on quality and production provided through aquaculture offers a potential opportunity for premium pricing in niche markets. | Threats<br>• Lack of private sector support.<br>• High market prices in the fresh market are based on small volumes. Increased volumes could decrease prices. |

## Evaluation Framework

The standard species evaluation framework presented in the table below, Table 3.23, presents a picture that is similar to that presented for yellowtail flounder. The economic viability of witch flounder aquaculture is highly questionable, based on low growth rates, the high-capital investments necessary (which generate few jobs) and the unknown level of commitment by the private sector. These factors support the conclusion that at present witch flounder should be a low-priority species for development in Newfoundland.

**Table 3.23: Witch flounder - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Optimal temperature conditions are unknown. As a flatfish species, it is best suited to land-based culture. | U |
| Production Potential - Biological | • Juvenile production is possible with good survival rates. | + |
| | • Ongrowing has not yet been studied, but it appears that there would be very slow growth at this stage. | - |
| Production Potential - Economic | • Witch flounder is not considered to be economic at the current slow growth rates. | - |
| Marketing Potential | • A premium flatfish species, it often rivals halibut in price. | + |
| Human Resource Capabilities | • Trained R&D personnel with species experience are available at the OSC. | + |
| Availability of Capital - Private | • Private sector commitment is unknown. | U |
| Availability of Capital - Public | • Future public research agency support depends on industrial support. | - |
| Employment Generation Potential | • Land-based facilities are capital-intensive, and create few jobs. | - |
| Stage of Development - Timing to Commercialization | • Further R&D is needed to determine commercial viability; a minimum of three to five years will be necessary for evaluation prior to commercial development. | - |
| Assessment | • The economic potential for this species is highly questionable; it should not be a priority for development. | - |

**Recommendations**

- This species should be considered as a low priority for development. It does not warrant the support of public funding for commercialization.
- Additional R&D efforts should be small-scale, and should focus on determining whether growth can be improved to economic levels.
- Funding support for continued applied R&D efforts by relevant agencies should only be provided if backed by continued industrial support.

### 3.3.4 Soft Shell Clams

**Introduction**

Soft shell clams have been harvested for over 100 years in eastern Canada and the northeastern United States, primarily in the New England states. Production in the United States totalled 1,277 tonnes in 1998, while the Canadian harvest, which was marketed in New England, was quite limited. Recently, because of over-fishing and a decline in natural habitat for the animal, interest has grown in the possibility of culturing the soft shell clam in Maine, New Brunswick, Prince Edward Island and Newfoundland.

Development of the species' culture has resulted in the establishment of successful hatchery techniques, which are used in hatcheries in Shippagan, New Brunswick, and the Beal's Island Hatchery in Maine, to produce seed. The seed produced is used by the hatchery to seed local clam beds. Wild spat collection techniques have also been developed.

**Markets**

The market for soft shell clams is centred in New England where demand is high during the summer months. The shellfish are commonly steamed and eaten in the shell, although they are widely fried and used in "clam rolls" as well. The limited supply of the species has kept the prices fairly high in recent years. In 1997 prices reached $9.52 per kilogram and in 1998, $9.58 per kilogram. In late 1999, prices ranged between $105 and $110 per bushel.

**Aquaculture Development in Newfoundland**

One company in Newfoundland, Innovative Fisheries Development Inc. (IFD), holds a lease to culture clams. The lease covers a 390-hectare lot in the Burgeo area. The company started work on its clam flats in 1994 and from that development harvested 75 tonnes of fresh clams for sale in the United States in the same year. The company has continued work on the clam beds, creating a detailed GIS on the area. IFD is interested in using culture techniques to increase the sustainable harvest of the species in the area.

In 1998, Dr. Jay Parsons studied the area's potential for wild spat collection. While inconclusive, the study did not uncover large recruitment in the area. Dr. Parsons recommended that hatchery production or wild seed collection from other areas be considered.

**SWOT Analysis**

Table 3.24 below summarizes the strengths, weaknesses, opportunities and threats facing the development of soft shell clam aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix L).

| **Table 3.24: SWOT Analysis - Soft Shell Clams** |
|---|
| Internal |

| Table 3.24: SWOT Analysis - Soft Shell Clams | |
|---|---|
| Strengths<br>• Clam flats with relatively large clam populations exist.<br>• Extensive study of clam flats on the Southwest Coast has resulted in the development of a detailed GIS for the area. | Weaknesses<br>• Newfoundland's colder water temperatures result in clam growth that is slower than that of clams in other areas.<br>• Depuration is needed in identified clam areas.<br>• Spat counts appear low; therefore, potential for wild spat collection is questionable.<br>• The economics of soft shell clam aquaculture are unknown, but they would be questionable, especially if hatchery seed is required. |
| External | |
| Opportunities<br>• Strong demand and prices characterize the New England market.<br>• Wild-resource declines in New England area open up an opportunity for aquaculture. | Threats<br>• Newfoundland's ability to compete with production from warmer areas is questionable. |

## Evaluation Framework

The standard species evaluation framework presented below in Table 3.25 indicates that, at best, soft shell clams are on the fringes of consideration as an aquaculture species at present. Very little work has been done on this species' aquaculture in the province. Although culture techniques have been developed, the viability of culture is unknown and Newfoundland's cooler water temperatures and slower growth may adversely affect potential viability. Overall, the species should be considered as a low priority for commercial development in the province at this time.

**Table 3.25: Soft Shell Clams - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | • Soft shell clams grow in Newfoundland, but our colder water temperatures generally result in growth rates that are lower than other producing areas. | - |
| Production Potential - Biological | • Hatchery culture techniques have been developed. Wild spat collections are also possible. | + |
| Production Potential - Economic | • The economics of soft shell clam aquaculture are unknown but questionable. | - |
| Marketing Potential | • Strong demand and prices are enjoyed in the major New England market, fueled by a limited supply. | + |
| Human Resource Capabilities | • Scientific resources for R&D are available through MI/MUN. | + |
| Availability of Capital - Private | • Availability of private sector capital unknown. | U |
| Availability of Capital - Public | • Future public research agency support is dependent on industrial support.<br>• Clam culture has been identified by the Long Range REDB as a potential priority. | U |
| Employment Generation Potential | • Seeding and harvesting can potentially be quite labour intensive.<br>• Applicable to limited areas of the province. | +<br>- |

| Table 3.25: Soft Shell Clams - Evaluation Framework | | |
|---|---|---|
| Stage of Development - Timing to Commercialization | • Further R&D is required to determine whether wild spat collection is viable; the timing to commercialization is unknown. | - |
| Assessment | • The future viability of soft shell clam culture is questionable; it is not a priority for development. | - |

**Recommendations**

- This species should be considered a low priority for development. It does not warrant the support of public funding for commercialization.
- Additional R&D efforts are needed to determine recruitment potential or the need for an outside source of seed. This should be pursued only if clam aquaculture can be shown to be potentially viable.
- Funding support for continued applied R&D efforts by relevant agencies should be provided only if backed by continued industrial support.

### 3.3.5 Seaweeds (Kelp)

**Introduction**

Worldwide, seaweed aquaculture is a multi-billion dollar industry, valued at close to US$6 billion. Cultivation produces 87% of the total seaweed production, primarily from sites in Asian countries. (Seaweed aquaculture in Canada and the United States is limited.) For the most part, seaweeds are cultivated for human consumption, although they are also processed for use in animal feeds, fertilizers, soil additives and medicines. Seaweed extracts are used in a variety of products including chocolate milk, canned meats, cosmetics and soaps.

Increased harvesting pressure on wild stocks, which resulted in dwindling wild harvests and good market prices, provided a major impetus behind the growth of seaweed culture. The speed in the growth of the industry was also made possible by scientific and technical breakthroughs in the development of improved strains. Further growth of seaweed aquaculture is expected.

**Markets**

Prices for seaweed vary greatly, depending on the use for which they are intended. In 1990 *Laminaria* fetched between US$6 and $30 per kilogram dried, while it was worth only $400 per tonne as a chemical feedstock. A British Columbia company reportedly is selling its kelp for human consumption and use in nutraceuticals at prices between Cdn$30 and $70 per kilogram. Extracts tend to earn the best returns, as much as $60 to $80 per pound ($130-180/kg)..

**Species Aquaculture in Newfoundland**

While Newfoundland seaweed producers are not culturing seaweed at the moment, they believe that aquaculture will be critical to the future profitability of their operations. They refer to problems sourcing wild seaweed, which is in limited supply and is often inaccessible in poor weather. In addition, aquaculture will provide a control on product quality, which varies in wild stocks, as well as consistency in production.

Recently, the Isle aux Morts Economic Development Board commissioned the preparation of a proposal to develop a pilot-scale kelp culture project in their region. The completed proposal outlines a three-year approach to determine the potential for seaweed culture.

Assuming that seaweed aquaculture does turn out to be biologically and economically feasible for the region, it would create, in addition to the benefits cited by producers, long-term economic development, job creation, and the generation of successful initiatives for the Regional Economic Development Boards.

**SWOT Analysis**

Table 3.26 summarizes the strengths, weaknesses, opportunities and threats facing the development of seaweed aquaculture in Newfoundland. These factors are based on a detailed assessment of industry and market conditions and issues facing development (See Appendix M).

| **Table 3.26: SWOT Analysis - Seaweed (Kelp)** | |
|---|---|
| Internal | |
| Strengths<br>- Proven culture techniques are available for *Laminaria*.<br>- World-class scientists in seaweeds have committed their support to the development. | Weaknesses<br>- Biological, technical, market and economic factors for kelp aquaculture in Newfoundland are largely unknown and untried. |
| External | |
| Opportunities<br>- A large established market for seaweed products exists. Premium products in select markets are capable of commanding premium prices.<br>- Control of quality and production provided through aquaculture offers the potential opportunity for premium pricing in niche markets. | Threats<br>- Access to private sector support and financing for commercial development is unknown.<br>- The ability to develop premium markets and supply them with a premium product has been untried as yet. |

## Evaluation Framework

As outlined in the standard species evaluation framework presented in Table 3.27, below, seaweed aquaculture in Newfoundland is at the beginning stages of research. It is not possible at this time to evaluate the commercial potential for culture. As such, this species cannot be considered as a commercial priority for the Newfoundland aquaculture industry.

**Table 3.27: Seaweed (Kelp) - Evaluation Framework**

| Evaluation Factors | Discussion | +/- |
|---|---|---|
| Biophysical Suitability | - Seaweeds grow better in cooler temperatures, and quality is reduced in high temperatures. Growout is proposed from October to May/June.<br>- The availability of adequate nutrients and irradiance to support growth and quality is unknown.<br>- Any farm area should have land-fast ice, to prevent damage from moving ice.<br>- The seaweeds are suitable for fairly shallow water areas, from 20 to 30 feet. | U |
| Production Potential - Biological | - *Laminaria* species have been proven in culture elsewhere, but their performance in the local environment is unknown. | U |
| Production Potential - Economic | - Performance, cost and market data are required to determine potential viability.<br>- The potential for one-season growout exists. | U |
| Marketing Potential | - Established high-price markets exist for high-quality kelp products.<br>- Market and product development research is required. | + |
| Human Resource Capabilities | - There is a lack of knowledgeable personnel in kelp aquaculture in the province; extensive training and technology transfer will be required. | - |

## Table 3.27: Seaweed (Kelp) - Evaluation Framework

| | | |
|---|---|---|
| Availability of Capital - Private | • Private sector partners are to be involved in a pilot project, providing minimal investment.<br>• Access to required private sector financing for commercialization is unknown. | U |
| Availability of Capital - Public | • The project has been identified as a priority of the Marine and Mountain Zone Corporation.<br>• Development will require government support through the initial research stages. | U |
| Employment Generation Potential | • The potential exists for direct job creation in hatchery, growout and processing operations. The majority of the jobs would be needed for processing operations.<br>• Significant employment generation has been identified for the pilot project phase. | + |
| Stage of Development - Timing to Commercialization | • The province is in the early research stage of development; a minimum of three years for evaluation is needed prior to commercial development | - |
| Assessment | • This is a research project; seaweed aquaculture is not a priority for commercial development. | - |

**Recommendations**

- This species should be considered a low priority for commercial development. It does not warrant the support of public funding for commercialization.
- The proposed research should take a staged approach, with identified milestones, where "go/no go" decisions can be made based on the performance in our environment. Research funding should be tied to reaching and passing such milestones.
- Strong private sector involvement should be a prerequisite to moving forward on development.

## 3.4 Summary

The evaluation framework for each of the 13 species under consideration is summarized in Table 3.28. This table indicates that there are a limited number of species which should be considered as priority species for commercial development at this time. Species which hold a reasonable potential for commercial development within a relatively short timeframe include salmon/steelhead, mussels and cod.

For the remaining species various negative or unknown factors make them poor to at best moderate candidates for commercial development in the near term. A number of species are currently uneconomic for commercial development. Others have poor or unknown markets. Many are not supported by strong private sector involvement. For most the lack of success generated by prior public sector investment brings into question the availability of future public sector support. For those with a high land-based component capital costs are high and the potential for job creation is low. The majority of species are a number of years away from the potential establishment of commercial operations.

**Table 3.28: Species Evaluation Framework Summary**

| Evaluation Factors | S/S | M | C | | GS | Ch | E | Yf | SU | | | AH | W | Wf | SS | SK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S | FC | | | | | FC | LB | B | | | | | |
| Biophysical Suitability | + | + | + | + | M | M | M | M | + | + | + | M | + | U | M | U |
| Production Potential - Biological | + | + | + | + | M | M | M | M | U | + | + | M | M | M | + | U |
| Production Potential - Economic | M | M | + | U | - | - | U | - | U | U | + | U | - | - | U | U |
| Marketing Potential | + | + | + | + | M | M | + | - | + | + | + | M | - | + | + | + |
| Human Resource Capabilities | M | M | M | + | + | M | M | + | - | + | + | + | + | + | + | - |
| Availability of Capital - Private | - | - | M | + | - | - | - | U | - | U | U | M | - | U | U | U |
| Availability of Capital - Public | M | M | + | U | - | - | U | - | - | U | U | M | - | - | U | U |
| Employment Generation Potential | + | + | + | + | + | - | - | - | - | - | - | - | - | - | M | + |
| Stage of Development - Timing to Commercialization | + | + | + | M | M | - | + | - | - | - | + | - | - | - | - | - |
| Assessment | + | + | + | M | - | - | M | - | - | - | M | - | - | - | - | U |

*Legend:* S/S-Salmon/Steelhead; M-Mussels; C(S)-Atlantic cod, Seasonal Growout; C(FC)-Atlantic cod, Full Cycle; GS-Giant scallops; Ch-Arctic charr; E-American Eels; Yf-Yellowtail flounder; SU(FC)-Sea Urchins, Full Cycle; SU(LB)-Sea Urchins, Land-based Roe Enhancement; SU(B)-Sea Urchins, Bottom Culture Roe Enhancement; AH-Atlantic halibut; W-Wolffish; Wf-Witch flounder; SS-Soft shell clams; SK-Seaweed (kelp)
+ positive assessment; - negative assessment; M mixed assessment; U unknown

Concentration of effort on the few species with the best chance for commercial development is in line with one of the issues echoed by many industry stakeholders, the need for the Newfoundland aquaculture industry to focus. A discussion of this and other industry issues is provided in the following section.

# 4.0 ISSUE SUMMARY

An extensive series of interviews was conducted with major stakeholders in the Newfoundland aquaculture industry. These discussions were used to develop a profile of each sector of the industry, to identify the major issues facing each sector of the aquaculture industry and the industry as a whole and to prioritize these issues with respect to their potential impact on the future development of the aquaculture industry. The following pages outline the primary issues in the culture of individual species and those issues that were common across the various species. A detailed discussion of the issues facing each species is provided in Appendices A through M.

## 4.1 COMMON ISSUES

Discussions with stakeholders identified a number of important issues which were common across many stakeholders and species.

### 4.1.1 Industry Focus

The Newfoundland aquaculture industry consists of a wide variety of species at various stages of development. Species range from those closest to being commercial, salmon/steelhead, mussels and cod, to species that are still in the experimental stages such as wolffish, soft shell clams and seaweed. One theme arose consistently in discussions with industry stakeholders not involved in specific species development and with many industry players: the need for the Newfoundland industry to focus on developing a success story or stories, rather than spreading and diluting its efforts over a wide range of species.

Success stories are required to generate a meaningful level of confidence in the industry and to provide a basis for attracting investment, both private and public, into the industry. "The Newfoundland Aquaculture Industry needs a success story. Success in this industry is a combination of technical know-how and economic viability.... It's the economic successes that will really drive development and consequently we must promote the current species which show economic viability along with those with future potential" (Brian Rogers & Associates: 1996).

Public- and private-sector stakeholders, no matter how committed they are to the development of the industry, must be provided with proven examples of success to enable them to continue their commitment of resources to the sector. This is especially true in the public sector, where there are many competing demands for limited resources.

In an increasingly globalized environment, private sector investment will seek out the best source of risk/reward value from a wide range of investment choices. This holds true in the aquaculture industry where more and more investment is crossing country boundaries.

### 4.1.2 Common Marketing Issues

Investment in the marketing of products from the aquaculture industry has not kept pace with the investment in infrastructure and technology. Aquaculture is an industry which by its nature has several potential marketing advantages. The managed and controlled farming of aquatic products confers the ability to produce a consistent, premium quality product. The product can be harvested and processed in an orderly fashion into premium product forms. With this level of control, the aquaculture industry has the potential to obtain maximum benefits from the resource. However, to secure maximum returns, the industry must market its products. All too often the industry relies on sales and brokerage rather than actually marketing its products.

### *Product-Market Matching*

The vast majority of the private- and public-sector funds invested in the Newfoundland aquaculture industry has been expended on developing and refining hatchery and growout technology. A relatively small portion of the funds has been dedicated to market research and development. However, developing a product without a serious eye to the market is a dangerous proposition. Manufacturing companies do not produce one million widgets without having secured markets for their production. In the same way, the Newfoundland industry must match its production to the market. A case in point was the situation in the steelhead sector this past summer where product in the water was not matched with the market opportunity in the United States. As a result the industry had to find new market outlets very late in the game and fortunately were able to enter the Japanese market.

Expansion of production just for the sake of expansion is not a wise decision. The industry must focus on ensuring that good, viable markets are available for its products. To do this, much more emphasis has to be placed on gathering market intelligence, and on product marketing and promotion. This holds true for all species, both commercial and developmental.

### *Marketing vs Selling*

As previously indicated, the industry has focused on selling, rather than marketing, product. The industry needs to become more involved in the marketing of its aquaculture products as premium products.

## 4.1.3 Financing and Investment Issues

### *Cash Flow Position/Equity Position*

Many Newfoundland aquaculture enterprises have undertaken R&D and have developed their businesses with commercial sources of funding. In many cases, their initial equity has been eaten up by losses during the developmental period. Now burdened with debt loads and little equity, many do not have access to other sources of equity and are seriously undercapitalized. The question remains as to whether the support that was provided for pre-commercialization R&D can be restructured.

### *Investment Sourcing*

There is a lack of private investment capital required to grow the industry. Some aquaculture entrepreneurs are reluctant to dilute their shareholdings in order to attract private capital. As well, many have sustained operating losses and carry deficits on their balance sheets. This makes them less attractive to prospective investors and makes it difficult to lever public investment.

Attracting private capital is required to facilitate growth and maturation of the industry. Investment prospecting and industry promotion could assist in developing sources of private investment capital.

Sourcing strategic investments that would bring management or marketing or processing expertise along with investment capital would be a desirable strategy, adding value as well as investment.

### 4.1.4 Regulatory Environment

Many Newfoundland aquaculturists hold the view that the regulatory environment is unduly restrictive. Common complaints centre on "unnecessary" red tape which adds ill-afforded costs; inadequate consideration of biological time frames in the timing of issuing permits/approvals; and the uneven and restrictive manner of enforcement. Many aquaculturists are concerned that Coast Guard regulations are being applied restrictively in Newfoundland to the detriment of the industry.

The government departments feel that the industry has been lacking in its compliance with established regulations and disagree that the environment is unduly restrictive.

Many aquaculturists and industry participants believe it would be very beneficial to have "sector champions" operating on industry's behalf in various departments and agencies, to clarify and improve the regulatory environment. It was also suggested that more Department of Fisheries and Aquaculture personnel should be involved in outreach and extension activities and that these personnel not be responsible for regulatory enforcement.

### 4.1.5 Management/Leadership

Many aquaculture operators lack business management skills. If the industry is to be successful, it is imperative that its companies access or develop these skills through outside hiring or training. It is evident that there is a need for business and management training to be made available to existing and prospective aquaculture operators. Certain critical skills, such as inventory management, cash flow management and planning, clearly need to be developed. The possible option of providing modular, targeted outreach training might be considered. Assistance in identifying outside support with the skills required could also be helpful.

There is also a perceived lack of leadership in the industry. It is clear that the industry cannot yet boast of an industry opinion leader, or a clearly successful enterprise leading the charge on industry development issues.

### 4.1.6 Human Resource Issues

Aquaculture is an industry that requires a high level of skills. Skills are needed in the areas of species biology, farm management and technology usage, and business management. The industry must also have access to the required skills in marketing and processing to ensure that the aquacultured product is generating the maximum return possible.

Finding all of these skills in one person is extremely difficult, if not impossible. However, in the Newfoundland aquaculture industry, too often entrepreneurs have attempted to fill all these roles, stretching themselves beyond their core capabilities and thereby negatively affecting corporate success.

In general the skills most lacking in the industry lie in the areas of marketing and business management. The industry must attract or develop the expertise required in these areas to be successful. Skills training and upgrading must also be available to ensure that the biological and technical requirements are being fully addressed.

## 4.2 SPECIES SPECIFIC ISSUES

For each different species there are specific issues which are impacting on current and future potential development. Species-specific issues are detailed in Appendices A to M. Table 4.1 outlines for each species the issue categories that are having the greatest impact. *Although other issues exist for each species under each of the other categories, this section highlights only those issues deemed as most important.* The following pages identify the primary issues facing each species.

**Table 4.1:** Primary Species Issues

| Issue Categories | S/S | M | C | GS | Ch | E | Yf | SU | AH | W | Wf | SS | SK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broodstock Issues | ▨ | | | | ▨ | | | | | ▨ | ▨ | | |
| Hatchery Issues | ▨ | ▨ | ▨ | ▨ | | | | | ▨ | | | | |
| Growout Issues | ▨ | ▨ | ▨ | | ▨ | ▨ | ▨ | ▨ | ▨ | | ▨ | ▨ | |
| Processing Issues | | ▨ | ▨ | | | | | | | | | | |
| Marketing Issues | ▨ | ▨ | | ▨ | ▨ | | | ▨ | ▨ | ▨ | | | |
| Technology Issues | ▨ | | | | ▨ | | | ▨ | ▨ | | | | |
| Fish Health Issues | ▨ | | | | | | ▨ | | | | | | |
| Regulatory Issues | ▨ | ▨ | ▨ | | | | | | | | | | |
| Economic Issues | | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | |
| R&D Issues | | | | | | ▨ | | | ▨ | | | | ▨ |
| Financing and Investment Issues | ▨ | ▨ | ▨ | ▨ | | ▨ | | | ▨ | ▨ | | | |
| Infrastructure Issues | | | | | | | | | | | | | |
| Human Resource Issues | ▨ | ▨ | | | | ▨ | | | | | | | ▨ |

Priority areas shown as shaded

*Legend*: S/S-Salmon/steelhead; M-Mussels; C-Atlantic cod; GS-Giant Scallops; Ch-Arctic charr; E-American eels; Yf-Yellowtail flounder; SU-Sea urchins; AH-Atlantic halibut; W-Wolffish; Wf-Witch flounder; SS-Soft shell clams; SK-Seaweed (kelp)

### 4.2.1 Atlantic salmon/Steelhead trout

The salmonid sector in Bay d'Espoir is a commercial sector. The primary issues for the commercial sectors are those which, if tackled, will lead to further industry growth and improved profitability. The following pages outline the primary issues for Atlantic salmon and steelhead trout, as derived from the analysis provided in Appendix A. In terms of priority, to achieve growth and improved profitability the industry must focus on three main areas:

- Bringing the required private sector investment and expertise into the industry;
- Reducing costs, and
- Increasing economies of scale, through farm growth and increased collaboration.

#### *4.2.1.1 Primary Issues*

***Broodstock Issues***

Steelhead trout

- Stock selection - Ontario (Rainbow Springs) and Quebec (Alleghanys) stocks have not performed well in Newfoundland conditions. The "Silver Bullet" strain from Troutlodge appears to be providing much better performance, although strain comparisons completed in Chile showed this strain to be the poorest performer of six tested. Chilean producers use Danish and Swedish stocks. In Maine, the Donaldson strain is used.
- Triploidy - Field trials with triploid strains have generated generally disappointing results. "Triploids have fewer, larger cells and demonstrate a reduced aerobic capacity compared to their diploid siblings. As well, triploids have a different mechanism for storing energy reserves and, as a result, they have an impaired ability to recover from stress.... The changing conditions of the Bay d'Espoir culture environment (i.e. salinity, temperature, oxygen, etc.) would be highly stressful on triploid stocks...Given the choice, it would be preferable to culture all-female diploid trout rather than triploid strains" (CAS: 1999, p. 11). The "Silver Bullet" triploids showed good performance this year, as compared to the Alleghany strain. Long-term performance, however, has not been proven. Although proven as superior in other environments, the long-term performance of steelhead diploids in Newfoundland is also unknown.

Atlantic salmon

- Stock selection - Various stocks have been selectively developed for improved growth and other characteristics. In Chile and British Columbia, the Mowi/Landcatch salmon have provided best performance. The McConnell strain has also been used in British Columbia. In Maine, Mowi/Landcatch and Bolax hybrid strains are being used, as well as Penobscott and St. John River strains. By government regulation, New Brunswick is limited to the St. John strain. The best performing strain for Newfoundland's conditions has not been determined.

***Hatchery Issues***

- In their analyses of the industry, Canadian Aquaculture Systems and Mr. Tim Edwards have both stressed the importance of producing high-quality smolts or fingerlings in contrast to the production of large quantities. SCB has revised its hatchery strategy to concentrate on producing large, healthy smolts and/or fingerlings. The hatchery is primarily focusing on the production of Atlantic salmon smolts for the company's own cage growout operations. This causes a problem for most of the remaining players in the industry who have depended on the SCB hatchery for their supply of fingerlings. These growers must now find an alternate source of supply. It is estimated that, to maintain production at its current level, the industry will have to source between 600,000 and 900,000 additional smolt/fingerlings. As such, the sourcing of fish is of fundamental concern to the industry.

Discussions with industry players indicate a preference for sourcing these fish through the development of a new hatchery in the Bay d'Espoir region. However, no industry players have indicated plans or the financial ability to construct such a hatchery.

The alternatives to developing a hatchery in the Bay d'Espoir region include shipping in fish from hatcheries in the Maritimes (either at a size suitable for entering saltwater or at a smaller size for input to a relay hatchery in or outside of Bay d'Espoir), and the development or redeployment of other capacity within the province to supply the Bay d'Espoir region.

Industry players in New Brunswick and British Columbia indicate that shipping smolt/fingerlings over long distances does not pose a problem. Hatcheries are established where water quality is best, not necessarily where growout sites are located. "There is an obvious need for another hatchery, and bearing in mind fish movements are possible, even routine for periods of up to eight hours or more, the location of a hatchery need not be confined to the Bay d'Espoir area" (Tim Edwards: May 1999).

- The development of a new hatchery to supply the Bay d'Espoir region should be a private sector initiative, preferably by an established, experienced salmonid sector player. Hatchery development is a proven, viable business opportunity. The ability to attract the investment required for establishing a hatchery in Newfoundland will primarily depend on the perceived strength and stability of the growout sector and its financial ability to purchase smolts or fingerlings from a new hatchery.

### *Grow Out Issues*

- By industry's own admission, husbandry practices are quite variable from one farm to another. Farm practices impact on production costs and can also have significant effects on fish health and quality. Fish health impacts on one farm also have the potential to negatively affect other farming operations. As such, husbandry practices are an industry-wide concern and not just the concern of individual farmers. The development and implementation of Best Practices will be central to ensuring that farms are using at least a baseline of good husbandry practices. In British Columbia, an industry-led Best Practices committee has been established for self-policing the industry. Such an initiative warrants serious consideration in Newfoundland.
- **Competing in a global marketplace, the industry must focus on reducing costs of production. The primary cost of production in fish farming is feed cost, making up 60% to 70% of total costs. Improving feed conversion ratios (FCR) and specific growth rates (SGR) has to be an ongoing industry priority. The quality of feed, strain performance and feed management practices all affect overall feed costs. Another significant cost factor for feed is the transportation required to bring feed into Bay d'Espoir from off-island feed producers.** Measures to reduce transportation costs should be investigated. At present, one of the major feed suppliers to the industry is investigating possible feed transportation alternatives with the potential to provide a significant reduction in feed transportation costs, as well as reduced transportation costs for product leaving the island.
- **Economies of scale also impact on production costs. Discussions with industry indicated that farms have to produce at least 300 to 500 tonnes or more to be viable. On a worldwide basis, trends are toward larger production units of 1,000 tonnes or more. Scale economies are important in getting the best productivity from labour,**

**receiving reduced prices on supplies and spreading fixed costs over higher volumes. Opportunities may exist for collaborative buying within the industry, which will increase volume purchases and reduce costs.**

- Additional overwintering sites will have to be identified for further expansion of the industry beyond 8,000 to 10,000 tonnes. They will also be required before expansion, at lower production levels, to enable single year-class separation and adequate site separation during overwintering.
- The introduction of diploid steelhead may create the opportunity for a one-season growout cycle, based on the input of large fingerlings (weighing more than 150 grams) in the spring. This could expand the productive capacity of the Bay d'Espoir region well beyond the restrictions imposed by overwintering. The potential for early maturation of large fingerlings may impact on this opportunity.

### *Marketing Issues*

- Marketing issues for the Newfoundland salmonid sector relate primarily to the marketing of steelhead. In relative terms, Newfoundland is a very small producer of both salmon and steelhead and, as such, is a price taker in the market.

  Until 1999, over 95% of steelhead production was sold in the Northeast United States market in fillet form, making Newfoundland a relatively large player in this market. Through its brokerage representative in the United States, the Newfoundland steelhead industry has been able to carve out a niche in the market. This market, however, has significant constraints on volume and price. External influences, such as the influx of steelhead from Chile two years ago, can have a detrimental impact on price. In 1-lb fillet form, steelhead is generally priced at $0.50 to $0.75 per pound less than Atlantic salmon, and this market price is highly sensitive to increased volumes.

  The Newfoundland industry has relied largely on a single broker to handle its salmonid sales in the Northeast United States. Attempts have been made to distribute volumes through additional sources, but it has generally been found that such activities face barriers of volume inflexibility and result in Newfoundland product directly competing with itself, driving down prices (Brian Rogers: personal communication).
- A potential alternative market outlet for the Newfoundland steelhead is the Japanese market. The industry and market profiles presented in prior sections have shown that at present the demand in this market is exceeding supply, and prices have reached very attractive levels for the primary suppliers in Norway and Chile. As with all fisheries products supplied to the Japanese market, colour and appearance are major factors in product grading and pricing. The Norwegian and Chilean steelhead sectors are producing their product specifically for the Japanese market using the amount and type of pigmentation required to reach the preferred level of redness. The product form in this market is a head-off, gutted, collar bone-in frozen product.

  Select members in the Newfoundland industry have been feeding enhanced levels of pigment in an effort to produce a product suitable for the Japanese market. Marketing of this product has been undertaken, and two Japanese companies have sent quality control technicians to the area0. Through the efforts of brokers, including one of Canada's major fishing companies, major sales were secured with the Japanese buyers by two of the largest independent operators in the Bay. A total of approximately 800 tonnes of steelhead were sold into the Japanese market in 1999.

  The development of strategic alliances with the fishing industry, who have the experience and contacts required to enter the Japanese market, may offer significant opportunities for the Newfoundland industry. With a lack of freezing capacity in the Newfoundland aquaculture industry, such alliances will be required at least in the short term. Arrangements have already been made by the fishing company currently involved to develop a marketing plan for next year's steelhead crop with one of the major independents early in the new year.

- For the Newfoundland industry, which in September 1999 had over one million steelhead in the water that were market ready in the fall, product-market matching is of critical concern, both in the immediate future and longer term. For now, the sale to the Japanese market mentioned above reduced the steelhead numbers in the water at year's end. This was important as past experience in overwintering steelhead for a second year have resulted in mortality rates of approximately 15%.

  In the intermediate to longer term, it will be necessary to further develop and market to the fresh market in the United States. Marketing efforts to establish Newfoundland steelhead fillets as a premium product in the market are required. This will increase volumes and create an awareness of Newfoundland as the primary supplier of steelhead to the Northeast United States. For the Japanese market, projections are for continued strength in this market. In this market, Newfoundland product will compete head-on with Norwegian and Chilean production. Although prices are strong at present, for a long-term presence in this market Newfoundland producers must be competitive on cost, price and quality. As many Newfoundland fishing companies have a long-standing relationship with the Japanese market, strategic alliances between salmonid producers and these companies may offer the best alternative over the longer term.
- The logistics and cost of distribution to market are of concern, especially when competing in the US market with other Atlantic provinces' product, which can be shipped to market at a lower cost. As previously discussed, transportation costs for feed into Bay d'Espoir and product out of Bay d'Espoir are a concern, and alternatives to reduce these costs are being evaluated.
- The investment in the salmonid sector in Newfoundland, and most other jurisdictions, has been made primarily in the production side of the business. In the future, equal weighting will have to be given to market development as a critical investment requirement.

### *Technology Issues*

- Automation is occurring throughout the salmonid industry. Farms are automating to reduce labour costs and to improve growth and feed efficiencies. A variety of technologies are being used to monitor and control farming operations, from automatic feed dispensers and feed management equipment, to constant site monitoring with camera systems. At present the Newfoundland salmonid sector is using minimal automation, with some farms using cameras and feed blowers.

### *Fish Health Issues*

- Chronic disease outbreaks have plagued the Bay d'Espoir industry. Outbreaks have included Vibrio, IPN, Furnuculosis, Swimbladder Stress Syndrome and a tape worm infestation. The small size and poor quality of fish produced at the hatchery have been major factors contributing to the fish's susceptibility to disease. The unstable salinity levels in the inner reaches of Bay d'Espoir place additional stress on small, unhealthy fish, further increasing their risk of disease. Husbandry has also played a part in disease risk, with excessive stocking densities, improper net cleaning, mortality collection and disposal, and feeding all cited as contributors to disease outbreaks.
- Fish health is a primary concern in the Atlantic salmon sector. Discussions with industry

participants indicated a recognition that Atlantic salmon offered potentially higher margins for the farmer, due to the fish's higher market price and larger size. Most noted that increased farming risk in salmon due to fish health issues, and the improved steelhead performance in 1999, were the primary reasons for their hesitation in switching to Atlantic salmon production. Although the Newfoundland salmonid sector has been subject to various sources of disease, the primary concern in the industry at present is the threat of furnuculosis in salmon. Major disease outbreaks of furnuculosis in Atlantic salmon did occur in 1999 and there is some evidence that resistance to antibiotics is developing within the stock. Industry participants indicated that vaccine development is the key priority for this problem. Other ways to reduce disease outbreaks include husbandry improvements, such as the use of deeper nets and reduced densities, moving to sites with higher salinity further out in the Bay, and potentially using a vaccine booster.

- An issue that was highlighted in many industry discussions was the current handling of mortalities. At present, dead fish are collected and shipped for dumping. The bins holding the mortalities are brought to shore over the same wharf used for feed distribution and harvesting. The potential disease implications of this activity were raised by numerous players. Industry players believed that on-site incineration of the dead fish would be preferable to the present practice.

### *Regulatory Issues*

- A major issue that has limited the development of the salmonid sector in Newfoundland has been the inability to access outside stocks for culture in Bay d'Espoir, under the NASCO-NAC protocols. This has also dampened the interest of outside players in establishing in the region. Through the efforts of NAIA and the Department of Fisheries and Aquaculture the industry has recently been given approval to import strains of diploid steelhead trout and Northwest Atlantic strains of Atlantic salmon. These approvals are subject to the development and implementation of a code of containment for the industry. These efforts should enable farmers to produce better performing steelhead and salmon.
- Canadian Environmental Assessment Agency (CEAA) requirements regarding assessment requirements for new sites may be an issue for future expansion activities.
- Government and industry have taken proactive steps in the development of a management plans for the industry which cover such areas as species and year-class separation, introductory sizes for fish and overwintering. Continued consultation is required to ensure these plans are maintained up-to-date.

### *Financing and Investment Issues*

- **Private sector - An overriding concern for the industry is the lack of equity and available cash. This issue, brought about by years of recurring financial losses is impeding the industry's ability to deal with the other important issues outlined in this section and to take advantage of opportunities for further development. Enterprises that have sustained operating losses and carry deficits on their balance sheets are less attractive to prospective investors. Attraction of private capital to the salmonid sector is critical for its future survival and growth. Investment prospecting and industry promotion could assist in developing sources of private investment capital.**

  **Sourcing strategic investments which bring management and/or marketing and/or processing expertise along with capital would be a desirable strategy since it would add value as well as investment. "Salmon and trout farming are a global business. Major**

**producers may have operations throughout the world. Investment decisions are made across all these countries based on the relative profitability of operations in each area. A host of factors influence investment decisions including the costs, distance to market, size of operations, and the regulatory environment. Attracting international investment is important to the future growth and development of the East Coast salmon farming industry" (CAIA: 1999, p. 3-6).**

- Public sector - The public sector has been the primary source of capital for the salmonid sector. Federal and provincial sources have expended tens of millions of dollars in the development and maintenance of the industry. Given the poor performance of the industry and its inability to make payments on outstanding repayable contributions, further investment from existing public sources is unlikely. For many of the existing funding sources, the industry will be required to start showing positive financial performance before further public funding will be made available. A continuation of the improvements made in 1999 will go a long way toward restoring public confidence in the industry.

### *Human Resource Issues*

- Management and Leadership - Many aquaculture operators lack business management skills. There is a need for business and management training to be made available to existing and prospective aquaculture operators. Some critical skills such as cash flow management and planning are clearly lacking. The possible option of providing modular, targeted outreach-type training might be considered. The hiring of the required expertise is another viable option.

  There is a perceived lack of leadership in the industry. There is no leader in industry opinion or a clearly successful enterprise leading the charge on industry development issues. SCB clearly overreached its core competencies and human resource capabilities by spreading its operations over hatchery, growout and processing and marketing.

### 4.2.2 Mussels

The mussel sector is the only other sector of the Newfoundland aquaculture industry which at the present time could be considered as commercial. As with the salmonid sector, if the primary issues are tackled, further industry growth and improved profitability will follow. The following pages outline the primary issues for mussel aquaculture development, as derived from the analysis provided in Appendix B. To achieve growth and improved profitability, the industry must focus on the following priorities:

- Increasing private sector investment, strategic alliances and other forms of collaboration within the industry;
- Reducing costs;
- Increasing the utilization of approved sites; and
- Increasing economies of scale for growers and processors, through growth and increased collaboration.

#### *4.2.2.1 Primary Issues*

***Hatchery/Seed Collection Issues***

- The larval and spatfall monitoring program which has been place for five years has been very successful in increasing the amount and reliability of seed production. Discussions with industry indicate strong support for this program, which is viewed as critical for the continued growth and development of the industry.
- Seed collection has demonstrated that sites are highly variable. A number of sites have been found which provide excellent spat collection and growth during the first year. The potential exists to designate these sites as seed producing sites for the industry, enabling growers to utilize their sites solely for growout. The separation of seed and growout sites is common in other jurisdictions and warrants consideration by the Newfoundland industry. Some of the province's growers have started moving in this direction, with designated seed and production sites.
- Secondary set of mussels is of concern, especially among developing South Coast mussel producers. The research and development of protocols for management of this problem are required.

***Grow Out Issues***

- Implementation of Best Practices in mussel husbandry is required to develop mussel sites to their full potential and increase mussel production efficiency. While a preliminary Best Practices manual has been prepared for the industry, it will require further development and utilization by the industry.
- **Cost reduction is needed to improve farm viability and automation is required along with improved husbandry to increase yields per sock. For growing farms, investments in equipment, such as barges, are necessary to improve operating efficiencies and reduce operating costs.**
- Site productivity. Most mussel sites in the province are producing at less than projected output, often generating as little as 5% to 15% of projected revenues. "Why are sites underperforming? Primary reasons are probably lack of technical know-how viz husbandry and biology, high expectations of production levels (versus realistic up-front projections), lack of operating money, and insufficient attention to management (site and business). What

causes the extreme variability in site production? Primary reasons are environmental conditions (i.e., site selection) and husbandry/site management. What analysis should be done before sites are licenced as commercial? Some evaluation of business, husbandry, and management competency (this would include the ability to develop and follow a business plan). A demonstrated 'alliance' with someone buying mussels - why grow them on speculation? Environmental tests would include temperature, food, and current flow estimates over a year. Of course, test lines for growth would be useful, as would some estimate of product yield. Finally, the usual things like access to infrastructure and a labour force would have to be considered" (Couturier: 1999, p. 22). The under-performance and high variability exhibited by the industry causes problems for funding partners when projections are not being met.

- Shipping costs to processing plants can be very expensive, especially if the grower is obtaining only a 30% to 40% yield at the processing plant. This is especially true for the South Coast, where long shipping distances currently exist to processing plants. Growers need to be able to improve their husbandry practices to improve product consistency and investigate the potential for de-clumping and grading prior to shipping to increase saleable yields, and thus reduce transportation costs per pound.

  Collaborative efforts among farmers on improved husbandry and holding and shipping would ensure that farmers are shipping full truck load volumes and that a very high percentage of product shipped to the processing plants is saleable.
- Farmers who are not situated in an area with a high concentration of mussel growers will be at a disadvantage. In such areas farmers will have a reduced potential for collaboration, to reduce costs on transportation and purchases. Small scale production in an area would not warrant the establishment of processing capabilities, therefore requiring farmers to ship product long distances for processing. As such, it would be expected that in general farmers in isolated areas would be subject to a higher cost structure than those in areas where a "critical mass" of production is available, to enable viable processing operations to be established and collaboration among farmers for cost reduction. At present, areas with such a critical mass are limited to the Northeast Coast. The South Coast is moving toward developing this critical mass but production must increase to beyond 2,000,000 pounds before "critical mass" is achieved. Therefore, for isolated farms, the economies of scale needed to become viable would be higher, in general. than the projected 500,000 pounds, given their higher cost structure. The circumstances of individual farms may vary somewhat.
- At present, approximately 2,500 hectares is leased to mussel sites in the province. The actual rate of utilization of this capacity is very low. Even if the assumption is made that a significant proportion of this area is not, or is only marginally, suitable for commercial mussel production, the leased acreage should still be capable of supporting at least 5,000 to 8,000 tonnes of production. PEI is producing over 12,000 tonnes using a similar lease area. Because of this underutilization, the Department of Fisheries and Aquaculture is no longer considering new leases and is taking back leases that are not being utilized until production increases. This policy has the support of the major growers in the province. Taking back unproductive leases could open up new areas to dedicated farmers for production expansion. At present, the policy only calls for lease suspension if no utilization is taking place. An additional policy directive that may be warranted is the retrieval of leases that do not meet a set baseline of productivity/utilization.
- **Mitchell Planning Partners identified a critical strategic issue that remains the top priority for growout: The need to build the profitability of existing, full time, dedicated**

**growers who are committed to building a professional mussel aquaculture industry through increased production volumes. There should be no attempt to increase the number of farmers.**

*Processing Issues*

- Existing primary and secondary processing capacity within the industry is more than enough to handle current production and greatly expanded production. "There are currently at least eight registered mussel processing plants.... All existing mussel plants are undercapitalized.... [There are four] operational mussel plants...in central Newfoundland, and one on the Northern Peninsula. In practice, these plants have the 'capacity' to handle all of the fresh product being produced and future production to about 5,000 tonnes. However, there are some constraints. Three of the plants have some live holding capacity but it is limited and sometimes not even employed. Reasons for the live holding include: extending shelf life of live product for shipment, rewatering and cleansing mussels of internal grit and dirt and storage of product for up to a few weeks to ensure availability to markets (during freeze up and thaw and under adverse weather). Sufficient live holding capabilities are needed if issues of quality and market expansion are to become reality.... Another problem with existing processing operations is that they are not located in ideal places. Product on the south coast is really too far to be shipped to the north east coast without compromising mussel quality during transport. One solution could be to have re-watering and grading stations in the south and ship to the north for final grading and packing. Another solution could be to have one plant situated on the south coast in a central area. On issues of secondary processing, I believe there are at least two plants capable of handling all of the primary product produced to date. The difficulty here is that there has to be a commitment to buying the product, provided it is of the right quality. Currently, there is not much of a volume of quality raw material for the secondary sector and I don't see that changing much in the near future" (Couturier: 1999, pp. 19-20).
- Industry production estimates for the upcoming year are not expected to show increased overall production. "Based on the available information, a shortage of production is projected for 2000" (Couturier: 1999, pp. 14, 38). This reinforces the statement that current primary and secondary production is more than adequate.
- Regionalization - New areas such as the South Coast will warrant the introduction of processing capacity once economic levels of production are reached. The addition of processing capacity for this region must be based on a sound business plan covering the requirements for managerial, technical and marketing expertise.

  Consolidation of the excess processing capacity on the Northeast Coast may be warranted. Spreading production too widely reduces the potential economic viability of all operations. Discussions with industry indicated that production of at least two to three million pounds is required for viability.
- Most processors lack the required fundamental expertise and scale economies in marketing and sales (Mitchell: 1998).
- The potential exists for reductions in operating costs in existing plants, through increased automation and efficiencies. None of the plants are currently equipped to handle gray tubs, and live holding and ice making capabilities are generally inadequate.

*Marketing Issues*

- The Newfoundland mussel industry has developed based on the almost exclusive sale of fresh mussels to markets in Canada and the United States. Recent developments have seen entrepreneurs enter the industry for the development of secondary products, primarily frozen, in-shell packs.

As outlined in the market profile, the market for fresh mussels in Canada and the United States has shown strong growth in the past decade. This strong growth is projected to continue into the future. Canada is the primary supplier to the fresh market, primarily through the production in Prince Edward Island. Newfoundland processors have been successfully increasing the market for their fresh mussels. However processors face competitive disadvantages as compared to PEI producers in transportation costs and logistics. The production of secondary products offers the opportunity to remove some of these competitive disadvantages, as the product is not shelf-life dependent. The market for secondary products has also been exhibiting positive growth trends. Producers are able to market the product to develop brand loyalty but still must be competitive with existing producers of secondary frozen product.

For the Newfoundland industry the opportunities are very good. The industry has the best potential for expansion of any Atlantic province. The markets for both fresh and secondary products are strong and expanding.

It is anticipated that Newfoundland producers will continue to market both fresh and secondary products, although it is felt that most expansion at this time will be directed into secondary products. The secondary processing sector must guard against overcapitalization, a common problem in the Newfoundland fishing industry. (The new shrimp fishery is a case in point, having greatly overcapitalized in only two years.) Overcapitalization leads to competition for resources, reduced efficiencies and reduced profits. Care should be taken to ensure that participants are able to reach an economic level of production.

- There are significant opportunities for continued penetration in both the fresh and frozen markets. There are also several issues to address. "The first is that there is a general lack of expertise in selling fresh mussels in this province. The main processing operations are also operating major farm sites, with all the ramifications therein. Though some have been in operation for nearly 20 years, they have learned the mussel-selling trade by trial and error. With the exception of perhaps one operation, none of the other 'alliances' has specific marketing and (or) sales expertise needed to keep on top of the market demands, to ensure that the product is sold to credible buyers who pay their bills, and to scan the global market for opportunities. The new mussel marketing group hired an expert but the costs were a significant proportion of the companies' operation. Volume will have to be increased substantially to offset this (necessary) cost in the long term." (Couturier: 1999, p. 17).
- The second issue related to markets is product quality. "Quality may be defined in a number of ways, but essentially it means a uniform product (size, shape, and meat yield,) that is consistent in qualitative aspects as well (colour, taste, appearance, shelf life, etc.) that the consumer wants. Some of the quantitative aspects may vary according to consumer demand (e.g., size and shape) but generally qualitative aspects remain the same. In order to sell mussels of any variety and to expand into the export market, one has to have a consistent quality of product. This has not been the case to date with Newfoundland producers and suppliers. One can buy mussels at local grocery chains that vary tremendously in quality with respect to size, meat yields, taste, odour, and shelf life. This has been verified experimentally by students at MUN. The present author is an avid consumer of mussels and just 3 weeks ago I bought 4 kgs of mussels for assessing 'quality'. Results were: meat yields 24%, approx. 10% dead mussels and at least 10% broken shells! These mussels would have

been harvested 4 or 5 days earlier, at the most." (Couturier: 1999, pp. 17-18).

- The third issue facing the Newfoundland mussel industry market efforts is volume. "To date volumes have been inconsistent at best and this has had major negative impacts on attempts to sell mussels. Moreover, the volumes are still too low for the industry to be considered a major player in the North American market. With a commitment to technological improvements to reduce costs of production and to ongoing extension support for husbandry, a core group of commercial growers should be able to bring production to the level needed, i.e., 5,000 tonnes by 2002-2003." (Couturier: 1999, p.18).
- Another issue in dealing with the market is the ability to meet the market's requirements for continuity of supply. As outlined in the Mitchell Planning Partners study:

  > "Large grocery and food-service customers require/demand weekly supply of farmed mussels as their retail shoppers or restaurant operator patrons expect and want and consume a continuity of supply;
  >
  > Large grocery and food-service customers want to partner with a limited number of large suppliers in order to meet their business/category objectives and growth needs."

  This study recommends the increased development of strategic alliances amongst growers and processors, to enable the development of weekly harvesting plans and thereby continuity of supply. Such alliances would also enable growers and processors to reduce their costs with respect to processing, marketing and distribution.

### *Regulatory Issues*

- A strategic initiative identified by Mitchell Planning Partners remains a priority for Newfoundland's mussel growers: Improve the effectiveness and efficiency of the governmental and regulatory approvals and administrative process, particularly in conflict resolution for site approvals. Significant efforts in conflict resolution have been made. These must continue as growers face opposition to the expansion of their mussel leases to increase their economies of scale and viability. Government-industry collaboration will be central to ensuring that conflict resolution mechanisms are available and up-to-date.
- An important regulatory issue currently facing the mussel sector is the Navigable Waters Protection Act regulation and policy and their application in the Newfoundland mussel sector. Continued discussion and collaboration between government and industry is necessary to ensure that this and other regulations are fair and equitable.
- New Fish Health Protection Regulations (FHPR) may impact on the movement of shellfish and finfish.

### *Economic Issues*

- Mussel culture is a proven commercial venture in many jurisdictions. The profitability of mussel operations in Newfoundland has been limited because most operations have been in the research and development stage, they have not produced at the economies of scale required for viability, and they have not met productivity targets.
- A study of mussel industry costs completed by Gardner & Coombs in 1997 identified the major factors affecting growers' production costs. They were as follows: the yields from socks and collectors; the amount invested in equipment in relation to annual production (i.e. achieving economies of scale); the farming methods and labour efficiency; and winter harvesting through the ice. "Yield is the most critical factor affecting the ability of a farm to operate profitably" (Gardner & Coombs: 1997, p. 41). As previously indicated, the yield obtained by mussel growers in Newfoundland has been highly variable due to various

factors. The Gardner & Coombs study indicated that a production of 150,000 lbs to 200,000 lbs would be required to reach break-even levels. **Major industry players believe that growth to 500,000 lbs or more will be required to establish long-term profitable mussel operations.**

- The same study indicated that the major factors affecting costs for processors were the volume processed, the price paid to the farmer, and the distance from the farm to the plant. The study indicated that in 1997 the processing industry was not profitable at its existing production levels. Subsequent increases in production have helped improve profitability for those processors with a large volume throughput. Processors have indicated that a yearly production of 2,000,000 lbs or more per enterprise would be required to secure a long-term profitable industry. This is supported by the analysis provided in the Mitchell Planning Partners study, "... a grower/processor strategic alliance should be a minimum of 2,000,000 pounds...(based on processing 7,500 pounds per shift for 240 shifts per year)."
- Mitchell Planning Partners considered overall industry profitability. They determined that as of 1997 the harvesting sector was marginally profitable but the processing sector was not. The study recommended expansion of the industry to over 20 million pounds to achieve an overall profitable industry with a total annual return on working capital approaching 30%.
- **Transportation costs are a major concern for mussel culture, which produces a relatively low-value product. High transportation costs can severely impact on farm and processor viability. With distribution costs to market at over 22% of the value received by processors and transportation costs of product to the processor at another 5% (Mitchell: 1998 and Gardner & Coombs: 1997), efforts to reduce these costs will have a direct effect on the bottom line. Recent reports by industry of significant increases in transportation costs provide added weight to this issue. It is uneconomical to ship anything less than full truckloads. Shipping of product from farms over long distances also affects potential viability. This supports the concept of increased industry collaboration and regional grading, holding, and production facilities.**

### *Financing and Investment Issues*

Private Sector

- **Most mussel growers in the province have limited access to private working capital or capital for equipment upgrading and site expansion. Growers have invested their available equity in the establishment of their operations and in undertaking the necessary R&D to develop their farms. Additional private sector investment will be required to develop many of these farms and processing operations to viable economic levels.** Consideration should be given to an investment prospecting program to attract required capital. For this to be successful, entrepreneurs will have to be willing to reduce their equity holdings. This is often a very difficult decision for individuals who have invested years of time and effort in establishing their companies.
- A major issue impacting on growers' available working capital is the long time they often wait to receive payment from processors for sales. In some cases, payment times have been in excess of six months. In turn, this is related to delays in processors receiving payments and their own restricted working capital availability. Working capital (cash) is the lifeblood of companies and the industry cannot be expected to achieve its potential if these conditions continue to exist.

Public Sector

- Through its development period, the mussel industry has received high levels of public sector support, from both federal and provincial sources. Assistance has been available for farm development and expansion and industry research and development. High levels of funding continue to exist for this industry sector.

- Major growers unanimously support the provincial Mussel Incentive Program. They agree with the continuation and possible expansion of this program to aid seed collection and technology transfer initiatives.
- "The establishment of a shellfish Aquaculture Working Capital Fund (AWCF) in June 1998 was deemed a step in attempting to address the industry priority of access to working capital. The AWCF objectives are to provide the 30% loan financing not generally available from private sources such as banks or venture capitalists (up to 50% is available from ACOA with a 20% equity requirement). Few if any shellfish producers accessed the fund in 1998. The major reasons outlined by industry in a workshop in December 1998 were: 1) the late announcement of the fund in June 1998; 2) overly stringent criteria for accessing the fund; and 3) availability of non-repayable working money from Human Resources Development Canada under the Transitional Jobs Fund. Government has undertaken a more thorough review of the AWCF criteria since this and though some of the funds are apparently being applied for and allocated to the shellfish industry, most producers are either not in a position (inability to meet equity requirements) or are unwilling to apply for this money. A number of producers have cited lack of information on the requirements and the continued 'restrictiveness' of the criteria as the main deterrents to applying for funding. In addition, newer producers are apparently not willing to take risks with loans for their business development given some continued uncertainties regarding the prospects of being able to sell their products at harvest time" (Couturier: 1999, pp. 9-10).

  Although a number of applications have been approved, problems continue to be experienced with the Working Capital Program. Industry is concerned with the length of time needed to get an answer on applications and with some of the criteria and restrictions. A problem for some growers is the prior debts incurred with ENL which are restricting their access to the program. Given that these are very old debts and that they were incurred in industry R&D during the early stages of industry development, consideration may be given to debt conversion or possibly forgiveness. The program was originally established only for growers. This caused a serious problem for processors who also required working capital, a large amount of which was needed to pay growers on a more timely basis. Changing program criteria to include processors is a positive move; monitoring should take place to ensure that this helps to reduce the payment times to growers.
- Concerns have been expressed regarding the timeframes required for funding approvals. Government departments and agencies need to have dedicated personnel, such as sector champions, in each department focused on aquaculture.

### *Human Resource Issues*

- Skills requirements. "There are currently a dozen or so commercial farmers that have at least some of the necessary skills and knowledge to operate 'viable' farms. There is however a general lack of business management skills/knowledge and of biological/production knowledge related to farming mussels. There are resources available to be tapped into but there needs to be a focused effort to providing the information and assistance in a suitable delivery mode, most likely field-based and one-on-one" (Couturier: 1999, p. 19). Growers and processors also need to consider hiring or contracting support in areas of weakness, such as business management.

- Full-time and part-time growers. Mussel production, as with all aquaculture, requires a dedicated effort in biological and business management for success. The industry needs to focus on support for those growers who are making a dedicated full-time effort to the establishment and growth of their businesses. At present, there are only 10 to 15 companies who are planning to grow to economic levels of production. These growers expect that a production level of at least 500,000 lbs will be required for a viable full-time business. The majority of mussel leases in the province remain in the hands of part-time growers. Production from these sites is very low and cannot be considered as the driver for future industry growth. Support should be focused on the full-time growers who have made a commitment to develop or hire the managerial, business and technical skills required for success.
- Extension support. "There is an ample human resource base within Newfoundland to tackle technical issues for the industry. However, provisions need to be made to ensure these people are employed for the purposes of assisting producers. When current ACERA projects terminate in early 2000, this resource base will diminish to a few individuals at the University. There are no available extension specialists within government to assist industry. Existing DFA shellfish personnel are committed to enforcement and regulatory issues over 90% of the time" (Couturier: 1999, pp. 18-19). DFA is now assigning staff to industry outreach roles separate from licensing and regulatory enforcement. These staff can become valuable extension support personnel in support of industry development.
- Training requirements. NAIA and the Marine Institute have been providing a series of industry workshops for training and skills upgrading. Three workshops for shellfish growers have been completed on hydraulics, oxygen providers and quality assurance. Further workshops are planned for this coming winter. "Proposed topics for mussel industry workshops for the winter of 2000 are: 1) Husbandry, harvesting and handling of mussels, 2) Culture biology and mussel performance, 3) Site assessment and suitability for mussel culture, 4) Regulatory issues affecting mussel culture, or combinations of the above" (Couturier: 1999, p. 9).

## 4.2.3 Atlantic cod

At present, Atlantic cod is not a commercial aquaculture species but it is viewed as having the best potential of the remaining species to become commercial in the near future. Seasonal cod growout is an expanding, profitable sector which has the potential for further growth, even though it faces limitations primarily in sourcing wild seed stock and addressing wild feed issues.

Cod aquaculture from the egg to market is still in the research and development stage. However, positive market developments, significant biological experience and advances, and a strong commitment from the private sector are in place. These factors increase cod aquaculture development's priority standing among the developmental species.

The following pages outline the primary issues for cod aquaculture development, as derived from the analysis provided in Appendix C. The issues facing seasonal cod growout differ somewhat from those facing full-cycle cod culture. Relevant issues are outlined for each sub-sector of cod aquaculture.

### *4.2.3.1 Primary Issues*

***Hatchery Issues***

- Hatchery production of high quality cod eggs and larvae has been accomplished in Norway, Scotland and Newfoundland (at the Sea Forest Plantation's Placentia hatchery; and in Nfld. Aqua Venture's (NAV's) production at Memorial University of Newfoundland's Ocean Sciences Centre). NAV produced 50,000 cod during the 1999 season.
- Development of strategies and rearing conditions to minimize aggression and cannibalism is a key early rearing issue. Frequent size grading has been the principal strategy used to manage the problem. NAV and the OSC will focus on live feed enrichments, feeding regimes and weaning regimes and diets to optimize juvenile survival. Newfoundland (OSC/NAV) will participate in the EU Cod Aquaculture Commercialization Research Project which is focused on commercializing full-cycle cod aquaculture.
- The refinement and standardization of hatchery protocols is required to maximize survival and larval growth.

***Growout Issues***

- Pilot scale growout of cod has been demonstrated in Newfoundland. The seasonal growout of cod from less than one kilogram onward has been successfully demonstrated over the past several years in Newfoundland (notably by Sea Forest Plantation in the late 1980s and early 1990s and again in the ACERA Project on Cod Growout in 1997-1999). Achieving juvenile growout (from 10 or 20 grams to approximately 400 or 800 grams) on a larger scale will be necessary in demonstrating the commercial potential of cod aquaculture in Newfoundland.
- The reliance of seasonal growout operations on a wild supply source will be a constant source of uncertainty for this sector of the industry. Recently announced recommendations for a cut in the 3Ps cod quota could impact on the availability of cod for farming operations in the year 2000.
- The development or demonstration of cost-effective feed for cod growout is an issue. The reliance on wild feed is an additional source of uncertainty, with respect to availability, cost

and quality.

- The physical and biological conditions required for cod growout are well defined and have been shown to exist in much of the Newfoundland coastal marine environment. While most cod growout has been centered in Placentia and Trinity Bays, it has also been undertaken on the South Coast, West Coast and Great Northern Peninsula.

***Processing Issues***

- The development of protocols for farmed cod handling and processing is required. Farmed cod is significantly different from wild cod in its texture and processing attributes. The farmed fish undergoes a longer and more pronounced *rigor mortis* process than wild cod. Additional research is needed to develop protocols for industry outlining the optimum processing techniques for farmed cod.

***Regulatory Issues***

- The limited access to wild cod juveniles for marine growout is an issue that may restrict growth in this sector. A cod growout pilot project is now completed and there are preliminary indications that 30 additional licenses will be available in 2000. It should be noted that only a small portion of the available licenses were used in the three years of the pilot project.

  The scale of cod growout is impacted by the volume of cod permitted on individual licenses. Fishers with cod growout licenses are permitted to partner or combine quotas to increase the scale of growout.
- New Fish Health Protection Regulations (FHPR) may impact on the movement of shellfish and finfish.
- Close links should be maintained with the Department of Fisheries and Aquaculture to ensure that its export policy continues to allow marketing of farmed cod to be conducted in the product forms required by the market place.

***Economic Issues***

- The economics of seasonal cod growout appear to be positive even at a relatively small scale. A study released by DFO in November 1999, "A Growers Guide to Small Scale Cod Grow-Out Operations", included a cost analysis for a 40,000 lb cod farm which indicated that, even at this low level of production profitability could be achieved. Seasonal growout is subject to lower risks than multi-year growout, which is required for most aquaculture operations. A note of caution: A problem may arise from the increasing cost of feed.
- The economics of full marine growout of hatchery produced cod have yet to be determined for Newfoundland. One company has indicated that it plans to develop a cod hatchery and to growout cod in the marine environment. The proposed hatchery would have the capacity to provide other enterprises with cod fry for growout. There are indications of private sector interest in the marine farming of cod.
- A commercial intermediate growout or nursery has yet to be undertaken in the province. It appears likely that such an initiative will begin, at least on a pilot scale, if cod fry become available. These initiatives, will, if implemented, demonstrate the economics of cod growout.

***Financing and Investment Issues***

- Historical financial data on cod aquaculture in Newfoundland do not yet exist (other than the figures that exist for seasonal growth). Preliminary economic modeling suggests that a hatchery (with an approximate capacity of 2 million cod fry) would require a capital outlay of approximately $1.5 million. Growout costs would of course be a function of scale and technology chosen, but it is unlikely that an economic farming operation could be capitalized and carried through to first harvest for less than $2 million. There is evidence of private and public interest in financing cod aquaculture. Sufficient private investment appears to be available to lever public funds.
- Seasonal growout operations have been established with low levels of capital investment, through the use and modification of existing gear owned by the fishermen. The primary financing requirement is for short-term working capital to cover the costs incurred during the six months or so of yearly operation. Primary costs include fish purchases, feed and other operating expenses. These costs can vary significantly between farms depending on whether the fishermen catch their own fish, supplement it with additional fish purchased from others, catch their own feed, etc.
- The expansion of seasonal operations to larger-size units would require additional capital and operating costs, for cage and net purchases, and fish and feed purchases.

### 4.2.4 Giant Scallops

Giant scallop aquaculture is not recommended as a priority for commercial development at this time. This species has been under development for many years and has received significant levels of funding support but has still not developed as a commercial species. The primary issues facing scallop culture development relate to the uncertainty regarding hatchery production and viability and the waning of private sector commitment and support for growout. The issues standing in the way of commercial development are outlined below:

***Hatchery Issues***

- Significant R&D efforts have taken place in algal culture, larval rearing, settlement and post-larval growth, and staff have monitored bacteriological and water quality in an attempt to improve hatchery production and identify factors affecting spat production. Nevertheless, the hatchery has not successfully established a routine operation capable of producing large volumes of scallops on a regular basis.
  Indications are that water quality problems have resulted in sporadic die-offs of larvae and spat, reducing production levels. The main water line was extended in an attempt to fix this problem and production improved in 1998. However, problems recurred in 1999 resulting in very low production numbers.

***Marketing Issues***

- Whole scallops. The market for cultured whole scallops is underdeveloped and has not been serviced with a consistent large supply of product. This has limited the market development potential. For fresh whole animals, shelf-life limitations restrict the geographical area in which these scallops can be sold. A niche market may be developed in the white tablecloth trade but further market development and penetration would require extensive and expensive development activities backed by access to a consistent product supply. "Markets for whole scallop are not nearly as well defined as those for scallop meats. Though the production economics are attractive (relative to meat production), there are greater risks with this product given its characteristics. Until the work needed to define and develop the whole scallop market is conducted, growers intending to target this market should proceed with caution" (Gardner Pinfold: 1998, p. G-11).

***Economic Issues***

- Hatchery/Nursery Economic Viability. At present, given the low level of production the scallop hatchery in Belleoram is not economically viable. The hatchery requires a nursery site to grow spat to saleable size. Yearly operating costs for the hatchery and nursery are estimated, based on historical costs, to be in the order of $250,000-$300,000 per annum. Based on a spat sales price of $0.03-0.05 per spat the hatchery would have to reliably produce 5 to 10 million spat on an annual basis to cover only its operating costs, not including its cost of capital. To provide a return to investors a production of 10-15 million spat per year would be required.
- Growout Economic Viability. Several studies have been undertaken to demonstrate the economic viability of giant scallop growout. These studies, including those by Atlantic Consulting Economists, Sharon Ford, Gardner Pinfold and a recent preliminary assessment of economic viability by the Department of Fisheries and Aquaculture indicate that scallop growout for meats provides a marginally viable opportunity, with internal rates of return projected in the 8% to12% range. Growout for whole live scallop sales could potentially provide much more attractive returns but only if the market for whole scallops can be developed. The economic analyses have been done for farms in the 500,000-1,000,000 scallops per annum size, which is much larger than any farm currently operating in Atlantic Canada. Overall, the currently available level of potential returns does not appear to be in line with the investment and level of risk required. "A rate of return in the 20-25% range would be considered minimally acceptable for a commercial operation, given the biological and market risks (Gardner Pinfold: 1998, p. G-10).

***Financing and Investment Issues***

- Public sector support. The public sector has provided millions of dollars of support to the scallop sector in the province over the past 10 to 15 years. As recently as three years ago, the public sector launched a major initiative to determine the biological and financial viability of hatchery and growout culture of scallops in the province. Public sector investment has not resulted in the development of a commercial scallop sector in the province. Further public sector support for continued hatchery and growout operations is questionable, although the Coast of Bays Corporation has expressed support for the hatchery and growout operations in its region.
- Private Investment. The prospects for further private sector investment in scallop culture in the province do not appear positive at the current time. One of the existing major growers has decided to focus his energies on the further development of his mussel production and processing operations. The owner of the other company is not committing to further investment; rather he is planning to sell the company.

### 4.2.5 Arctic charr

The Arctic charr is another developmental species which has also received significant attention and investment over the past decade. This species has not developed as a commercial sector and significant issues stand in the way of commercial development. These issues are outlined below:

***Broodstock Issues***

- Broodstock is a key issue in the development of Arctic charr culture. Broodstock problems and the lack of an available domesticated broodstock that provides consistent, fast growing juveniles have hindered the development of Arctic charr on a worldwide basis. The use of small, slow-growing strains of charr has blocked development in Newfoundland and elsewhere. There is hope, however, that research on broodstock selection and genetics, which is underway in Canada and Europe, will improve juvenile quality and growth.

***Growout Issues***

- Growth rates - Growth rates and their variability constitute a serious issue in the development of commercially viable Arctic charr culture. Fraser River and Nauyuk strains have not demonstrated the ability to grow to market size in an economically viable timeframe. Icy Waters claims that their proprietary strains are capable of reaching a market size in excess of 2 kg in 20 to 21 months from the hatchery and that current research is moving the growout period closer to 18 months.

***Marketing Issues***

- Product or commodity. The very low worldwide production of Arctic charr and its general reputation as a high quality, premium salmonid, together help to create the opportunity to differentiate Arctic charr from the salmon and trout commodities and to target the low production to upscale markets. This has been the approach taken by Icy Waters and they have been successful in obtaining premium market prices. Through controlled and cooperative marketing efforts it may be possible to retain the premium image and price as production increases. With no projected major increases in production output, this may be achievable.

***Technology Issues***

- Grow-out technology. It has been demonstrated that in Newfoundland cage growout is not viable, due to disease problems and slow growth rates. An extensive inventory of potential pond locations on the Northern Peninsula was unable to identify locations where temperatures would not threaten the outbreak of PKD.

  Groundwater usage in tank farms appears to offer better potential. However, indications are that to be viable, corporate land-based growout facilities will have to produce from 150 to 200 tonnes (G. Wilton, T. Flemming: personal communications). In Quebec, Saukev is increasing the size of their facility to 200 tonnes to attain viability. Hidden Valley Charr in Prince Edward Island is also undergoing a major expansion to its facilities.

***Economic Issues***

- Economic viability. Arctic charr has not been proven as an economically viable species for commercial development on a worldwide basis. This is illustrated by the very slow growth in worldwide charr culture over the past 15 years. In Newfoundland, the production of pan-sized fish in cage culture has been shown to be uneconomic. Growth to 1.5 kg or higher may be economic but only if a fast-growing, disease resistant charr strain is made available.

For land-based culture, an economic analysis of a 100-tonne production facility was recently completed (Moir et al: 1998). This analysis indicated that such a farm was not economically viable. The small volume produced by the farm and the resulting lack of economies of scale is the primary reason for this relatively poor return. Increasing production to 200 tonnes would provide a reasonable return on investment (over 15%). However, given the small production volumes of charr produced on a worldwide basis, the development of a much larger farm may be unrealistic. Higher production volumes may also have a detrimental impact on prices.

### 4.2.6 American eels

The potential for American eels is based on the technology transfer of equipment and growing techniques used with the European eel in northern Europe. The primary issues facing the development of American eel culture in the province include

- Seed stock for eel culture is in the form of wild glass eels. The availability and costs related to this primary farm input are sources of uncertainty facing the eel industry;
- The performance characteristics of American eels versus European eels must be documented to determine the impact on potential viability, and
- Successful development will depend on a strong private sector proponent, with access to the required financial, managerial, technical and market resources and expertise.

These and other issues facing the development of this potential opportunity are outlined below:

***Growout Issues***

- Supply of glass eels. Culture operation will be dependent upon obtaining an adequate supply of glass eels from the wild fishery. The strength of the wild resource is unknown, although recent declines in catches may indicate resource pressure. A recent report on the glass eel market and supply situation provided the following information on North American glass eel fisheries in 1999: "The Anguilla rostrata glass eel harvest has been unusual in North America this season. Catches have been low, many areas which were open in the past have been closed and the better than expected production of both Anguilla japonica and Anguilla anguilla has reduced market prospects. To date little has been heard about glass eel in the Gulf of Mexico... The only United States states open to glass eel fishing this year were South Carolina, Connecticut and Maine. The South Carolina fishery was a disaster. Only 100 kg were taken through last week and of ten licences reportedly only four were being fished. Connecticut opened 1 March and due to very cold waters and heavy snow very little was caught during the first week of March. Maine is scheduled to open 22 March and is heavily restricted and watched. On 4 March and 9 March Maine's State legislature approved an emergency measure to reduce the number of glass eel fyke nets by 70% and the number of glass eel fishing licences by 64%. The measure was largely the result of support from the Maine Elvers Association and other industry efforts to protect the resource. Maine's Marine Resources Committee unanimously supported the measures and the state governor was expected to sign them last week, according to the Bangor Daily News. The Eel Management Plan was due to be voted on by The Atlantic States Marine Fisheries Committee on March

17th. The fact that the number of fishers and the amount of gear in the Maine glass eel fishery more than doubled last year shows the extent of the problem. The new legislation calls for fishers to have a three year history in the fishery and this should effectively reduce the number of fishers from about 2,200 to 750. The fishery is apt to be closely patrolled. However, the market itself is apt to provide an important restraint on the fishery as there seems to be little market demand for North American glass eel's other than for limited domestic use. Some glass eel could go to Asia but it seems that it would only be under favorable conditions and at low prices. Chinese farmers reportedly have little cash for glass eel purchases, import permits and foreign payment permits are difficult to obtain and the availability of domestic and European glass eel has reduced demand. The Canadian Anguilla rostrata glass eel fishery is about to begin. Last year the harvest of glass eel in the Scotia-Fundy region was 2,029 kg, down 50% from the 1997 harvest. Details of the total amount of quota available this year and the intended markets are unavailable" (Bill Court, Fish Info Service: March 19, 1999).

At an average of 5,500 glass eels per kilogram, a 200 tonne commercial farm will require between one to three million glass eels (200 to 600 kg), depending on final product size and survival rates. The availability of a long-term source of supply of elvers is critical to farm development.

- Price of glass eels. The price of glass eels on the world market has fluctuated greatly in recent years. Glass eels are in demand for both human consumption and for aquaculture operations. The supply and demand situation in the major Asian and European markets has caused wide price swings. This is illustrated by the situation in northern Europe, as outlined by Dr. Urup: "For a number of years the prices were pretty constant normally fluctuating between Cdn$150-400/kg. In recent years the prices have reached considerably higher levels. The season 1996/97 started off with prices of Cdn$350/kg until the end of 1996, after which the prices started to increase, topping at Cdn$700/kg in February. The following year, 1997/98, the prices started off a bit higher than the year before, at Cdn$450/kg but then gradually dropped to just above Cdn$200/kg in February, but then drastically increased again up to as much as Cdn$900/kg in April. In 1998/99 there was an expectation that the prices would remain high and in December 1998 the prices were up to above Cdn$700/kg but then dropped to a level below Cdn$350/kg" (Urup: 1999, p.6).
- Growth rates and feed conversions. The production of 150 to 250 gram eels is possible in Europe in 12 to 18 months. "Feed Conversion Rates (FCRs) of 1.2 to 1.4 in Dutch eel farming are now possible, such have been the strides taken by the Dutch industry, says John van Dooren of Nutreco's Netherlands-based Trouw Nutrition...Nowadays the specific growth rate (SGR) of glass eels is on average 3 to 3.5%, and depending on quality, some farmers even reach 5%. Average FCRs of glass eels are below 1.0. The SGR of on-growing eel is 0.5% to 2.0%, depending on fish size and age of eel, while FCRs range from 1.4 to 1.2 and sometimes even 1.1" (*Fish Farming International*: Sept. 1999, p.46). The ability to achieve these growth rates and feed conversions with American eel in commercial culture must be verified.
- Quality. "One of the principal problems in farming of eels is the quality of the farmed fish. Most systems used today are still based on relatively old technology, with poor water quality, and no ability to operate with seawater. If the eels are produced with poor water quality in freshwater, the fish will typically have a muddy taste, which has its origin from a bacteria which only survives in freshwater. A system which has a far more stable water quality and/or

operates with seawater eliminates the problem... Farmers are typically using a salt bath to get around the problem, but clearly the fish does not thrive during a two weeks stay in a sodium chloride solution" (Urup: 1999, p.5).

- Feed availability and cost. As a relatively new and small sector in North America, the eel aquaculture business is not perceived as a priority for feed companies. In Europe, specialized feeds for eels are available at a much lower cost to farmers than the feeds in use in by the Newfoundland proponent. Development to commercial scale should enable larger feed purchases at lower costs and may warrant the development or transfer of specialized eel feed formulas to regional feed producers.

***Economic Issues***

- Economic viability. The economic viability of American eel aquaculture in Newfoundland is not proven. Eel aquaculture is a viable industry in Europe and Asia. An economic analysis of the potential for American eel aquaculture in Nova Scotia was prepared by Gardner Pinfold Consulting Economists Limited. This analysis for a 20 tonne farm using a turn-key recirculation system resulted in a highly negative Internal Rate of Return (IRR). "The base case assumes a 20-tonne facility, considered the minimum capacity for efficient operations by European standards.... Costs are based on recent estimates from European turn-key providers of proven systems. This capacity was selected for analysis because its capital cost is within a manageable range for small-scale enterprises. Larger capacity systems would generate higher rates of return due to scale economies on operations, but capital costs rise more or less in proportion to scale" (Gardner Pinfold: 1998, p.E-5). The operation being proposed for Newfoundland is a 200 tonne facility. This facility will take advantage of much greater economies of scale but is also expected to require an investment of approximately $3 to $3.5 million for fixed and working capital. The proponents are completing their business plan for the operation based on information from their pilot-scale experiments and from European operations.

***R&D Issues***

- American eel vs European eel. Growout protocols will require customization for the American eel over time. The performance and viability of the American eel must be demonstrated.

***Financing and Investment Issues***

- Private Investment. An investment of 25% to 35% in private equity can be expected for this project to proceed. The proponents have recognized this requirement and the potential need for external investment and investment sourcing.

***Human Resource Issues***

- The development of an recirculating eel aquaculture operation will require biological and technical expertise to grow the eels and operate the recirulation system. Training support will be provided in both areas by the equipment supplier.
- Managerial expertise will also be required to operate and manage a high-capital, intensive aquaculture operation.

### 4.2.7 Yellowtail flounder

Yellowtail flounder is characterized as a developmental species due to the fact that research has outlined the species primary biological parameters and enabled the production of pilot-scale quantities of juveniles. However, the potential for commercial exploitation is severely hampered by its growth profile. The primary issues for this species relate to its slow growth and the impact that has on potential viability. The primary issues are outlined below:

***Growout Issues***

- Juvenile growth. As shown in the growth profiles provided in Appendix O, a focus on juvenile nutrition has helped juvenile growth rates to improve significantly in 1997 and 1998. The largest size achieved at one year post-hatch is 35 grams and at 85 weeks post-hatch the largest juveniles have reached 160 grams. Projecting future growth indicates that at least three years post-hatch will be required to reach a market size of 800 to 1,000 grams. To date, juvenile growth trials have largely been undertaken at ambient temperatures.

***Fish Health Issues***

- Yellowtail flounder have exhibited a susceptibility to disease outbreaks (Dr. J. Brown: personal communication). Of all the species currently being researched at the OSC the yellowtail flounder has experienced the most disease episodes and appears to be highly susceptible to furnuculosis. Research to date has not focused on disease control or vaccine development.

***Economic Issues***

- Economic viability. The principal question on this species is: Can yellowtail flounder be produced at a growth rate that leads to economic viability? A preliminary analysis of the potential economics of yellowtail production was completed for FPI (Burke: 1996). This analysis considered both hatchery and grow-out production. To obtain an internal rate of return (IRR) of 15% on hatchery production the juveniles would have to be sold at a size of 5 to10 grams for $0.50 each. To achieve a similar rate of return for grow-out in a land-based system, under ideal conditions, a 250 tonne farm would have to produce market fish of 1,000 or more grams in 20 to 24 months and receive a premium market price of $6.00/kg HOG. To date the growth of yellowtail flounder has not reached the level required for viability. From a hatchery size of 5 to10 grams at 25 weeks, the fastest-growing fish have reached 160 grams in a further 60 weeks (14 months). These fish will require a minimum of 24 to 36 additional months to reach market size, versus the maximum of six to ten additional months allowed for economic viability.

### 4.2.8 Sea Urchins

Sea urchin aquaculture can take the form of full-cycle culture from the egg through to market size or the ranching and gonad enhancement of existing wild urchins. Efforts in Newfoundland have primarily focused on sea urchin roe enhancement, investigating the potential for both land-based and seabed culture. Trials have been undertaken by various public and private groups which have demonstrated the ability to increase gonad yield. Primary questions remain regarding the development of a standard industry feed and the potential economics of land-based or seabed culture. The primary issues for sea urchin aquaculture development are outlined below:

### *Growout Issues*

*Full-cycle culture*

- Growth. Preliminary trials have demonstrated the potential to grow urchins from egg to 50 mm test-diameter size in 24 to 28 months. However, very little information is known about the major variables affecting viability, that is, FCRs, SGRs, stocking densities, etc.

*Roe Enhancement*

- Feed Development. Efforts to develop a formulated feed that will provide good roe growth as well as high roe quality have shown mixed results. Early attempts produced a roe of poor quality. Improvements are being made and the potential of a formulated feed supplemented with wild kelp holds promise. In using wild kelp, the availability and access to the large volumes required for commercial urchin farming is of concern.
- Yield/Quality Variability. Pilot-scale projects have demonstrated a high degree of variability in the roe yield and quality among individual urchins in trials. For success, consistency in roe yield and quality will be required.

### *Marketing Issues*

- The vast majority of sea urchin roe sales takes place in one market, Japan, where premium prices can be obtained for high quality urchin roe. The dependence on this market and its seasonal, and often daily, volatility increases the market risk for potential aquaculture operations.

### *Technology Issues*

- Growout technology. The cultivation of sea urchins can take place in either land-based or ocean-corral structures. Land-based facilities are much more capital-intensive but offer the potential for a greater degree of control over growth parameters. Ocean corral structures can be easily established but are subject to uncontrollable environmental conditions. Site selection is extremely critical for ocean corral development. The site must be accessible in most weather, be close to a good source of urchins and the proper feed, and have high water exchange.

### *Economic Issues*

- Economic viability. The economic viability of commercial sea urchin aquaculture; either full-cycle aquaculture or roe enhancement, has not been proven. A preliminary economic assessment of sea urchin roe enhancement (Burke: 1997) indicated that, subject to a number of assumptions, sea urchin aquaculture had the potential to be viable. This preliminary economic assessment was based on the results of the laboratory-scale trials completed by Hooper *et al.* This economic analysis showed that sea urchin aquaculture had potential to be economically viable, especially if high quality, high roe yield urchins could be produced to garner a premium price in the market.

  To date, roe enhancement trials have generally fallen short on many of the assumptions presented in the economic analysis, including roe quality, roe enhancement rate and mortality levels. It is also expected that capital costs would be significantly higher for most entrepreneurs than those outlined in the preliminary analysis. The bottom culture pilot-scale trial completed by New Ocean Enterprises did provide positive results on the potential viability of ocean corral roe enhancement.

### 4.2.9 Atlantic halibut

The development of Atlantic halibut aquaculture has received international attention in recent years, with tens of millions of dollars expended on research and development initiatives primarily geared toward juvenile production. Despite these efforts the production of juvenile halibut has not reached a routine status. Newfoundland efforts at juvenile halibut production have met with limited success. As such, juvenile production remains a major issue for halibut culture. Other primary issues related to halibut culture are the economics of growout, based on using capital intensive land-based systems, and the market impact of increased volumes of cultured halibut. The primary issues for Atlantic halibut development are outlined below:

***Hatchery Issues***

- First feeding stage. As previously discussed, the first feeding stage has been the primary bottleneck in juvenile production for halibut on a worldwide basis. Significant progress in this area is being made in Iceland and Scotland and to a lesser extent in Norway. "Survival was earlier a problem throughout first feeding, but survival rates in the range of 30% from hatch to post weaning can now be achieved, and that will probably be further improved. A survival of 30% is very much equivalent to what is common in commercial hatcheries producing other marine fish species" (Urup: 1999, p. 9).
  Fiskey of Iceland have been successful in producing 300,000 juveniles through intensive culture in 1999. This company's success in first feeding can be attributed to high levels of hygiene in their production system and to their live feed enrichments providing the proper nutritional requirements for growth and survival. At the OSC, both of these areas require further work.

***Growout Issues***

- Early maturation of males. Male halibut have been shown to grow slower and mature at a much smaller size than females. Males mature at 2-3 kg in size versus females which can reach up to 12 kg before maturity. Maturity slows down growth and significantly increases FCRs, as energy is shifted from growth to reproduction. At this point farmers are selling the males at 2-3 kg and the females at 5-6 kg. Farmers have been receiving higher prices for larger fish. As juvenile production improves the culling of males or techniques for the production of all-female stocks will become important.

***Marketing Issues***

- Prices. The total wild harvest of Atlantic halibut has only been in the range of 4,000- 5,000 tonnes. The development of a sizeable halibut aquaculture industry will have a direct impact on market prices. Currently prices fluctuate widely with available supply, reaching peaks when supply is low. Development of a sizeable aquaculture sector could result in a more consistent supply availability for the market, reducing the variability of prices, at a range expected to be below current peak prices. "Halibut prices can be expected to drop from their high levels with expanding cultured production. Prices are currently on a modestly rising trend and are high relative to other whitefish species. They are rising partly because supply has declined by half over the past decade, and partly because we are enjoying a period of sustained economic growth. It would take only a modest level of cultured production to equal the wild harvest. Norway also is on track to accomplish this within the next five (to ten) years. Prices can be expected to drop, though weakness may be mitigated to some extent by greater supply stability. Since halibut is found primarily in white tablecloth restaurants, its demand will be susceptible to swings in general economic performance" (Gardner Pinfold: 1998, p. C-10).

- Market development. As volumes of farmed halibut increase significant market development efforts will be required to expand the market base. Attempts to sell a much greater supply only to existing markets would have a major downward impact on prices.

### *Technology Issues*

- Hatchery technology. Three primary technologies are being used for juvenile halibut production; the use of wild copepods, fully intensive culture with artemia and rotifers and the use of cultured copepods.

  For Newfoundland, the availability of wild copepods is a limiting factor requiring the development of more intensive techniques. The industry has not developed to a point where an optimal technology has been identified. As such, both cultured rotifer/artemia and cultured copepod techniques warrant study.
- Growout technology. "The bottleneck in the near future will be the growout units suitable for production of Atlantic halibut" (Urup: 1999, p. 10). Table I-3 in Appendix I outlines the pros and cons of three ongrowing technologies; cage culture or land based flow-through or recirculating systems. Cage culture potential in Newfoundland will be limited by ambient temperatures which are below the temperature required for growth (4C) for a significant portion of the year. Also, high temperatures in the summer impose the risk of exceeding upper temperature limits.

  For land-based systems to be cost effective temperatures must be maintained within the optimal range for growth (9-12C) on a continual basis. Continuous access to these temperatures is not available in the Newfoundland environment. Recirculation systems offer the potential to maintain optimal temperatures year-round. The preferred location for establishment of a land-based recirculation system would have access to cool water (<10C) on a continual basis, to minimize the requirement for very expensive chilling.

### *Economic Issues*

- Economic viability. An economic analysis of the potential for Atlantic halibut culture was presented by Gardner Pinfold using information obtained from Mr. Rolf Engelsen of Bergen Aqua AS in Norway. This analysis considered the viability of various scenarios for nursery and full market growout in land-based and sea cage systems.

  The economic analysis indicates that at present the rates of return possible on halibut grow-out are not very attractive. These analyses were all based on the assumption of available fry at a price of $4.75 per fish for a 25 gram juvenile. Although prices of juveniles have been dropping with increased levels of production, the viability of hatchery production based on such a price has not been proven.

  The internal rates of return possible on halibut culture are significantly affected by the very high level of capital investment required to establish operations. For example, a 1,000 tonne land-based recirculation farm is estimated to have a fixed capital cost of $15.9 million plus an additional $12.8 million in working capital required over its first two years of operation. Even though this farm is projected to achieve net revenues of $5.7 million per year starting in the third year of operation, the internal rate of return at a sales price of $12.00/kg is only

10%.

***R&D Issues***

- Developments in halibut culture to date have been the result of extensive private and publically funded research and development. "The Norwegian experience with halibut culture is encouraging, though not without its difficulties. Central to the early success are substantial public and private investment in research and development, and large aquaculture companies with the resources needed to absorb the risk and the inevitable early set-backs. Annual research funding is stated to be over $30 million, with total spending to date estimated to be in the $200-300 million range" (Gardner Pinfold: 1998, p. C-10).

  In Norway the research priorities for halibut have been outlined by Bergen Aqua AS. "Intensive juvenile production is given priority both at research stations and governmental funding of private industry. Trials are made with startfeeding early or also directly on formulated feed to reduce the need for the costly process of live feed production" (Bergen Aqua AS: 1999, p. 7).

  Significant R&D efforts remain to make halibut culture a commercially viable venture.

***Financing and Investment Issues***

- Private sector. Two private sector companies are involved in halibut aquaculture development in Newfoundland, Newfoundland Aqua Ventures (NAV) and Atlantic Halibut Farms (AHF). NAV has 25 broodstock being held at the OSC and has completed construction of its broodstock holding facility in Winterton, where these add additional broodstock will be held. The company is in the planning stages for the development of a cod/halibut hatchery in 2000. In 1999, three of the company's personnel worked at the OSC on the cod and halibut projects. AHF had eight broodstock at the OSC but lost all but one to unknown circumstances.
- Public sector. The public sector has been the primary supplier of funds for the halibut R&D activities undertaken at the Ocean Sciences Centre. In Newfoundland total public and private sector financing for halibut R&D has been in the range of $4-6 million over the past decade, a relatively small amount compared to the Norwegian investment of $200-300 million. This investment has helped put in place the infrastructure required for pilot-scale halibut production and has enabled Newfoundland researchers to greatly increase their level of knowledge in halibut culture techniques.

  The public sector's future role in Atlantic halibut research, development and commercialization must take into account a number of factors: (1) that it appears that the primary bottleneck to juvenile production in intensive production systems has been largely overcome in Iceland, Scotland and Atlantic Canada (R&R); (2) that the economic viability of halibut culture has not been proven; and (3) that moving forward with halibut commercialization in Newfoundland will be best suited to land-based facilities, which will entail very high capital costs. Given these factors future development will have to be largely private sector led, with support limited to those groups that demonstrate the high level of financial, managerial and technical competence required to move forward.

### 4.2.10 Wolffish

The primary questions regarding the development of wolffish aquaculture relate to product marketing. Wolffish is considered a trash fish in North America and is afforded a very low market value. For wolffish aquaculture to be viable extensive and expensive market development will be required. This and the other primary issues facing the development of wolffish aquaculture are outlined below:

***Broodstock Issues***

- Broodstock collection and acclimation. The collection and acclimation of spotted wolffish broodstock is a difficult process. To date, broodstock have been collected by divers. The spotted wolffish is highly stressed by high temperatures and must be maintained under controlled temperature conditions.
- Egg fertilization and incubation. Wolffish are internal fertilizers. Techniques have been developed in Norway and Russia for the fertilization and incubation of wolffish eggs. Similar techniques were developed in Newfoundland by Dr. Larry Crim for Ocean Pout. Technology transfer will be required to refine these techniques for wolffish fertilization in Newfoundland.

***Marketing Issues***

- Market research and development. To establish wolffish in the North American market, extensive market research and development will be necessary. The low volume of catch and its reputation as a trash or nuisance fish with no directed fishery have made wolffish a low-value species in North America. It is generally an unknown commodity throughout most of the retail and foodservice sectors. In contrast, higher volumes have enabled wolffish to develop a presence in Europe. Although landed prices are low to medium, wolffish can often be found on the menus of white tablecloth restaurants, enhancing its image. Akvaplan-niva has undertaken test marketing in Europe. Preliminary market trials have indicated that a potential price of 40 to 60 NOK/kg (Cdn$8 to $12/kg) may be achieved in the Danish market, with higher prices available for larger fish.

  The development of a market presence and image for farmed wolffish will need a large investment, projected to be in the millions of dollars. Wolffish appear to have favorable flesh characteristics for the white flesh market and marketing efforts may be successful in establishing farmed wolffish (perhaps under a different name) as a premium product for the high-end food service market. To accomplish this, the farmed product would have to be differentiated from the low-value wild product. Although this may be possible, the level of investment and market knowledge required to achieve this goal would greatly limit the list of potential product/market developers.

***Economic Issues***

- Economic viability. Not enough data are available to determine the potential economic viability of wolffish under Newfoundland conditions. In Norway, "an economical evaluation on wolffish done by Bergen Aqua has shown that prices should be NOK 50-60 (CAD 9.6-11.5) to justify investments in landbased production sites" (Bergen Aqua AS: 1999). Given the low market value of wolffish in the North American market, current financial viability is questionable

***Financing and Investment Issues***

- Private sector development of this species will require large investments in marketing, the development, or technology transfer, of production protocols and the development of land-based production systems. To date, however, there are no industrial partners identified for development in Newfoundland.

### 4.2.11 Witch flounder

The witch flounder is a research species which in limited trials has exhibited an excellent juvenile survival rate but extremely poor growth rates. The primary issues for this species relate to this poor growth and its impact on potential economic viability for the species. The primary issues are outlined below:

***Broodstock Issues***

- Broodstock collection. The collection of witch flounder broodstock is difficult. Attempts have been made to collect broodstock from fishing vessels but the fish have not survived the transport due to excess mucous production.

***Growout Issues***

- Juvenile growth. Growth rates for the limited numbers of juveniles produced to date have been very slow. Research on juvenile nutrition and optimal growth protocols has not been completed.

***Economic Issues***

- Economic viability. Not enough data are available to determine the potential economic viability of witch flounder. Witch flounder could be expected to achieve a higher rate of return than yellowtail because of its significantly higher market price and its similar growout conditions (see Section G.4). It is possible that viability could be achieved at a slightly longer growout period than that projected for yellowtail flounder. However, data provided to date by the limited juvenile production, indicate that this species has a very slow growth rate, which is even considerably slower than yellowtail. Potential economic viability is questionable.

### 4.2.12 Soft Shell Clams

The primary issues affecting soft shell clam aquaculture development in the province arise from outstanding questions regarding growth rates and potential economic viability, as outlined below:

***Growout Issues***

- Growth rates. The colder waters of Newfoundland produce growth rates that are slower than those of other producing areas.

***Economic Issues***

- Economic viability. Sufficient data have not been collected to determine the potential economic viability of soft shell clam aquaculture. In other areas, problems include high losses (of up to 65% in Maine) due to predation and theft on seeded clam beds, and high labour costs associated with seeding (Gardner Pinfold: 1998).

### 4.2.13 Seaweed (Kelp)

Seaweed aquaculture is at the very early research stages in Newfoundland. The issues and impediments to development have yet to be defined. As such, the issues facing the species in Newfoundland at present are R&D related. R&D is required to determine the species potential in the province. To do this R&D and potentially develop the species, expertise in seaweed aquaculture will be required.

The primary issues for seaweed culture development are as follows:

***R&D Issues***

- At this very early stage of the development of seaweed aquaculture in Newfoundland, all of the biological, technical and market issues are research-related.

***Human Resource Issues***

- Within the province, there are few people with any knowledge of seaweed aquaculture. Personnel will need training on seaweed culture techniques. The future development and success of seaweed culture will be influenced by the development of trained human resources within the province.

# 5.0 THE STRATEGIC PLAN

The strategy presented for the further development of Newfoundland's aquaculture industry has been developed in a framework involving an assessment of its history over the past 15 to 20 years, an assessment of the current status of each of the thirteen species and of the industry as a whole, and in the context of current market and industry circumstances in North America and internationally. The strategy is intended to present an action plan for addressing the primary issues facing the industry, as outlined in Section 4.0, over the next three-year period.

As required by the terms of reference for this assignment, the strategy is presented in a format that recognizes the stage of commercial development achieved with each species. Species have been grouped in three categories: commercial; developmental or pre-commercial; and research. Different strategic approaches and measures are proposed for the three categories of species.

## 5.1 INDUSTRY-WIDE STRATEGY

The analysis presented in Section 4.0 has identified a series of strategic issues that are common across Newfoundland's aquaculture sector. These issues include the requirement for industry focus, and the need to address common cost-control, marketing, financing and investment, regulatory, management/leadership and human resource issues. The following paragraphs outline a series of basic strategic recommendations on addressing these issues on a broad industry basis. Particulars regarding the recommendations for each species are given in later sections.

### Recommendation 5.1.1 Industry Focus

The aquaculture industry needs a success story. Substantial public and private sector dollars have been invested to date and there is a concern that the industry should be at a more advanced stage of development. Clearly there is a need to become more strategically focused and to determine which species offer the best opportunity for success in the short term and those that have long term potential. Based on the analyses provided throughout this document and the attached appendices, *there are four species which offer the best opportunity for success in the short term:*

*Steelhead trout,*
*Blue mussels,*
*Atlantic salmon and*
*Atlantic cod.*

*It is recommended that commercial public sector investment be targeted primarily toward the commercial development of these species. In addition, public R&D support, in the form of extension support and targeted applied research studies, should primarily be focused on addressing the outstanding issues for commercial development outlined for each of these target species.*

The salmonids and mussels are currently classified as commercial species and have been the primary focus of commercial development in the province. There are two opportunities for cod aquaculture development: 1.) seasonal growout and 2.) full-cycle aquaculture. Seasonal growout is considered to be pre-commercial while full-cycle cod culture is still in the research and development stages. The market, and environmental and biological aspects of cod aquaculture development make this a particularly attractive species for development. Seasonal growout is being established on a yearly basis. However, growth may be limited by impediments to accessing seed stock from the wild, feed availability, costs and quality, and by the associated opportunity costs facing fishermen. The success of cod growout will be predicated upon addressing these issues and encouraging more fishermen to transfer quotas to cage operations. To increase production and address the uncertainty over wild stock supply will require development of full-cycle culture. Although indications are promising on this front, biological and economic questions still must be addressed.

### Recommendation 5.1.2 Comprehensive Cost Reduction

The aquaculture industry is a highly competitive business operating in a global market environment. Given the commodity nature of the business, producers are required to be price-takers, rather than price-makers. In order to become competitive, it is essential that industry implement a comprehensive cost-reduction program so that it can withstand fluctuations in product supply and pricing. There are a number of key ways cost savings can be achieved:

- Achieving economies of scale;
- Application of best husbandry and health practices;
- Utilization of best stocks to achieve optimum growout cycle;
- Consolidation of marketing efforts; and
- Consolidation of processing efforts.

*It is recommended that a comprehensive cost reduction working group be established to implement these guidelines.*

### Recommendation 5.1.3 Strategic Alliances and Market Development

Greater priority must be given to long term market development if the industry is to achieve its growth projections. Historically the industry has been troubled by over-capacity in the processing sector and inconsistent product supply. Recent efforts to consolidate processing and marketing are encouraging; however, further consolidation is required if the industry is to achieve economies of scale. Newfoundland is entirely dependent on exports, and transportation costs are a significant factor in the cost of goods produced. It is felt that industry would benefit considerably from forming strategic alliances or joint ventures with organizations that have market expertise.

*It is recommended that the following actions be undertaken:*
- *Strategic marketing alliances and joint ventures be encouraged and financially supported;*
- *Product diversification through value-added processing be encouraged for select products where it is feasible;*
- *Quality production be emphasized;*
- *Workshops be coordinated on market status and development to keep members up-to-date on opportunities and challenges, and*
- *Industry be advised of sources of market intelligence information on market demand, product*

*availability and pricing.*

A wide range of market information sources are available. These sources include aquaculture trade newspapers and publications such as *Seafood Business*, market intelligence letters such as *Erkins Newsletter* and *Seafood Trends Newsletter*. In addition, there are a number of web sites which offer free information. These include FIS: Fish Info Services (www.fis-net.com) and Fishmonger (www.fishmonger.com.). There is also an informative web site available called Intrafish (www.intrafish.com).

The Department of Fisheries and Aquaculture should increase its market intelligence gathering and dissemination to the industry.

### Recommendation 5.1.4 Financing and Investment Support

For the Newfoundland aquaculture industry as a whole, growth is being stymied by the limited availability of private sector capital. Many long-time farmers and processors have accumulated debt, for example from ENL loans, which are still on the balance sheet. This accumulated debt has made the operators ineligible for additional assistance. Assistance from the Shellfish Working Capital Fund has not been drawn down at the anticipated rate. Similarly in the salmonid sector, the operators face many of the same financing challenges. Unless the financial situation is addressed, future industry growth will be hampered.

*It is recommended that*

- *A targeted investment prospecting program be put in place to match investors with willing industry players;*
- *Government review the industry debt situation and evaluate the options;*
- *A sector champion be appointed within the Department of Development and Rural Renewal to be responsible for the Shellfish Working Capital Fund, and a centralized decision making structure be implemented, and*
- *It be communicated to industry that program funding evaluation criteria are based on performance and require that the applicant possess the necessary technical, biological, financial, marketing and managerial prerequisites for success.*

Industry's ultimate goal should be to extract itself from the requirement for public sector funding support. Financing for the industry should ultimately come from private sector lenders, such as Farm Credit Corporation and the Business Development Bank. Development of a positive track record within the industry will assist in attracting this type of investment. The entrance of a substantial industry player to the industry and the attraction of investment capital would go a long way toward attracting this investment to the aquaculture industry.

### Recommendation 5.1.5 Continued Improvements to the Regulatory Environment

Aquaculture operates in a highly regulatory environment, involving both levels of government. Many regulations were developed for the capture fishery and conflict with aquaculture development. While a certain level of regulation is required, it is essential that rules be rational and not create unnecessary impediments to development and investment. While government is often blamed for the regulatory problems, it is recognized that industry must bear some of the burden of responsibility for non-compliance.

*It is recommended that the following actions be implemented to reduce conflict and improve the regulatory environment:*

- *All new aquaculture policies or regulations undergo a thorough impact analysis that considers requirements for successful implementation;*
- *A review of the "one-stop shopping" licensing process be undertaken to facilitate more timely approvals;*
- *Stakeholders remain up-to-date on developments in the legal review being completed by the Office of the Commissionaire of Aquaculture and the potential implications for the industry;*
- *DFO/DFA/Coast Guard/NAIA continue to work to develop a consistent and fair policy framework for the aquaculture industry, recognizing the role and rights of aquaculturists in the marine environment, and*
- *Effective conflict resolution should remain a priority for industry and relevant stakeholders.*

*At times government's regulatory responsibility conflicts with its development mandate. To alleviate this problem it is recommended that staff be assigned a responsibility for either regulatory enforcement or development but not both.*

*Industry must comply with existing regulations and work with governments to identify areas of concern in order to identify realistic and practical alternatives.*

### Recommendation 5.1.6 Human Resource Development

The aquaculture industry must have a human resource base with a broad range of skills and competencies. The industry is very cost-competitive and is rapidly evolving at a technical level.

#### Strengtening Industry Management/ Leadership

Business management and leadership skills need to be strengthened given the global competitiveness of the industry. Meeting this challenge will be essential for long term sustainability.

*It is recommended that industry be encouraged to hire experienced farm managers.*

*It is further recommended that support be provided for the following:*

- *Development of strategic alliances to attract investment and management from established industry players and*
- *Coordination of training initiatives, to develop business management skills development, in areas including inventory management, cash flow management and business planning, sales and marketing management.*

#### Strengthening Technical Skills and Competencies

The industry is rapidly evolving at a technical level globally as producers strive to become more technically and cost efficient. It is essential that the workers in the Newfoundland industry are kept informed of new developments so they may be applied to the local industry. This is an area that will require further training and skill development. To date, human resource development within the industry has been primarily targeted toward the biological/technical aspects of fish farming. Over the past two years, NAIA has organized a series of workshops for the industry which have been beneficial. Most recently, DFA has arranged for farm workers from Bay d'Espoir to complete a work term with British Columbia salmon producers. These are positive initiatives toward developing human resource skill set required in industry.

*It is recommended that the following actions be implemented:*

- *Coordinating skills upgrading workshops on technical issues such as finfish and shellfish husbandry practices;*
- *Placing high priority on developing business skills and focusing workshops on relevant subject matter, and*
- *Introducing a mentoring program to transfer skills and knowledge on related technical and business subjects, for example husbandry and farm business management.*

Moreover, where skills are absent, industry should be encouraged and given support to hire experienced farm management personnel.

### Recommendation 5.1.7 Extension Services

Of immediate concern is the absence of long term funding for initiatives involving extension services, technology/information transfer and innovation. There is no funding past March 31, 2001 to continue many essential services and support. Technology and innovation are key to overall industry competitiveness and development.

*It is recommended that DFA refocus and redeploy its staff to take a lead role in development and delivery of extension services in conjunction with industry and Memorial University.*

*It is recommended that priority be given to funding such initiatives as*

- *Improving farm and processing cost efficiencies;*
- *Supporting NAIA extension services to industry;*
- *Assessing and adapting new technology;*
- *Evaluating new strains, and*
- *Enabling the transfer of technical expertise and managerial support.*

*It is recommended that DFA re-evaluate its role with a view to providing greater extension services where needed. Individuals identified for extension service delivery must not be responsible for industry regulation.*

Where practical, personnel resources from the Marine Institute, Memorial University and other competent agencies should be utilized to assist in the delivery of these services.

### Recommendation 5.1.8 Research and Development

Research and development is critical to the aquaculture industry, to the development of new species, and to continuing improvements in reducing costs and increasing efficiencies in existing species. Two basic types of R&D activities are warranted for the Newfoundland aquaculture industry:

- Short-term applied R&D projects focused on reducing costs and improving efficiencies for commercial species, and projects with potential to affect directly a commercial farmer's bottom line; and

- Longer term R&D projects focused on new species development or addressing long-standing issues for commercial species.

*It is recommended that support be continued for R&D activities in support of the aquaculture industry. Priority should be provided to projects focused on improving the costs and efficiencies for the four priority species: steelhead, mussels, salmon and cod. The Canadian Centre for Fisheries Innovation (CCFI) and the Ocean Sciences Centre (OSC) should play a major support role with respect to aquaculture R&D.*

### Recommendation 5.1.9 Maintenance of a Strong Industry Association

The Newfoundland Aquaculture Industry Association (NAIA) represents industry interests in government liaison, the management of research and extension projects and training initiatives, and communication and public relations. NAIA has been the main driver behind the development of this strategic plan.

It is critical that a strong industry association be maintained for the Newfoundland industry. Such an association is needed to continue to represent the industry and to take a lead role in the implementation of this strategic plan. At its current stage of development, the Newfoundland industry is not in a financial position to sustain a strong association.

*It is recommended that continued public funding support be provided to the Newfoundland Aquaculture Industry Association.*

## 5.2 COMMERCIAL SPECIES STRATEGY

Three species have been classified as being commercial in the context of this strategic plan: Atlantic salmon, steelhead trout and blue mussels. Atlantic salmon and steelhead trout aquaculture initiatives have been focused in Bay d'Expoir, whereas blue mussel aquaculture is more dispersed around the coast of insular Newfoundland. The circumstances and strategic issues warrant blue mussels being addressed separately from Atlantic salmon and steelhead (together known as salmonids).

### 5.2.1 Salmonids

Salmonid aquaculture worldwide is a highly competitive industry which operates in a commodity sector. The future outlook for world salmonid prices is represented by a flat trend line at best and will more likely involve further price declines over the long term. Industry members are responding to the challenge this outlook presents by increasing their scale of production, through development of larger farms ,and industry consolidation and concentration. Economies of scale are critical to future farm and industry survival. Cost reduction remains key to maintaining a competitive position. The trend toward further industry consolidation and dominance by a small number of multi-national organizations is projected to continue for the foreseeable future.

Additional capital investment in salmonid aquaculture in Bay d'Espoir is unlikely until profitability is demonstrated and public and private sector confidence is restored. There is an urgent need for the development of a "success story". Several analyses of the marine environment in Bay d'Espoir have confirmed that it is conducive to marine cultivation of salmonids. There is widespread acknowledgment that the course most likely to produce this "success story" is the attraction of an established, successful salmonid producer into Bay'd'Espoir. Provision of experienced management and capital, by way of a joint venture, or buyout of an existing company or new start-up, would inject confidence and vigor to the sector.

Based upon existing infrastructure and investment, it is unlikely that industry will exceed 3,000 tonnes. Moreover, this would occur only if improved husbandry and cost reduction practices were implemented. The entry of an experienced industry player in the Bay d'Espoir salmonid industry would accelerate commercial development. A major investor would bring the capital required to upgrade infrastructure and provide additional management expertise beneficial for growout and marketing. If this occurred, it would be a realistic goal to target production of 5,000 tonnes of salmonids in Bay d'Espoir in a three-year horizon. Over the medium term, production could approach 7,000 or 8,000 tonnes.

The costs required in reaching these goals through the expansion of growout, hatchery and processing capacity are detailed in Table 5.1.

**Table 5.1: Salmonids Production Goal**

| Production Target | Capital Investment Required | | Incremental Employment[1] |
|---|---|---|---|
| 5,000 tonnes | Hatchery Capacity | $0.75-1.5 M[2] | +5-10 |
| | Processing Capacity | | |
| | Upgrades | $0.5-1.0 M | +5-10 |
| | New Build | $2.0-3.0 M | +5-10 |
| | Ongrowing Capacity (current capacity 3,000 T, an additional 2,000 T)[3] | $15.0 M | +15-25 |
| | Total Required | $18.25-20.5 M | +40-70 |
| 8,000 tonnes | Hatchery Capacity | $1.55-2.75 M[2] | +10-15 |
| | Processing Capacity | | |
| | Upgrades | $0.5-1.0 M | +5-10 |
| | New Build | $2.0-3.0 M | +5-10 |
| | Ongrowing Capacity (current capacity 3,000 T, an additional 5,000 T)[3] | $35.0 M | +50-75 |
| | Total Required | $39.05-41.75 M | +100-160 |

Notes:
1. Employment figures are estimates of incremental employment impacts. Employment impacts are dampened by the required focus on efficiency and cost reduction. Total incremental employment figures include a multiplier of 1.5 for spinoff benefits in service and support industries.
2. Hatchery costs vary for various options: building new hatchery, lake nursery, remodeling of existing underutilized capacity in province for salmonids, etc.
3. Growout costs (fixed and working capital) will vary with the species mix. Due to their longer time to market, salmon require 1.5 times the working capital of steelhead (Mr. George Parsons: personal communication)

### Recommendation 5.2.1.1 Investment Prospecting/Industry Promotion

The most essential element of the strategy for salmonids is the attraction of investment and management involvement by an established player in the international salmonid aquaculture industry. Depending on the willingness of the existing companies, this investment might be made in one of the current operations or in a new start-up operation. The benefits of attracting new investment by an established producer are as follows:

- operational expertise and leadership in the areas of husbandry, processing and marketing;
- access to capital needed to achieve economies of scale and reduce costs of production; and
- commercial profitability for the industry, and development of the "success story" that is needed to restore public and private sector investor confidence.

The investment climate in the international salmonid farming industry is now conducive to investment prospecting. There has been a recent trend in consolidations and corporate concentration (for example, Nutreco's acquisition of Marine Harvest, Stolt's acquisition of International Aqua

Foods). However, Newfoundland must prospect and promote 'opportunity' more so than established production capacity. Our relative proximity to the United States Eastern Seaboard market and our steelhead trout production capabilities may be key elements of a prospecting strategy. A window of opportunity for attracting strategic outside investment now exists which may close rapidly if the industry climate changes.

The provincial government and the industry association have already developed certain tools for promoting Newfoundland's salmonid aquaculture industry. These tools can be updated and enhanced to form the basis of an investment prospecting initiative.

*It is recommended that a targeted investment prospecting strategy be implemented.*

### Recommendation 5.2.1.2 Comprehensive Cost Reduction

The salmonid sector is dominated by a number of major players who have a very strong influence over the supply and price in the marketplace. It is widely acknowledged that the market price of salmonids will become more competitive as producers continue to focus on cost reduction. In view of this, it is essential that the industry become more efficient and cost-effective so that it is able to sustain periods of fluctuating prices.

*It is recommended that activities focus on a number of key areas where ongoing cost reductions can be realized:*

- *Application of best husbandry and health practices*
    - *Size and quality of fish*
    - *Stocking densities*
    - *Monitoring smolt/yield index (i.e., marketable flesh per smolt);*
- *Utilization of the best stocks to achieve an optimum growout cycle;*
- *Achieving economies of scale;*
- *Consolidation and focusing of marketing efforts, and*
- *Efficient use of processing capacity.*

### Recommendation 5.2.1.3 Product Mix and Market Development

There has been inadequate market development for Newfoundland's farmed salmonid products. While it is recognized that industry can grow both steehead trout and Atlantic salmon, industry players must make a decision on which species they intend to grow. Unless such decisions are made it will be difficult to undertake any long term market development initiatives. Until quite recently virtually all salmonid products sold in the United States were handled by one broker. The indecision on product focus and limited market development has prevented the Bay d' Espoir industry from establishing a strong niche in the market.

*It is recommended that the industry proceed with a strategy of growing both steelhead and salmon. However, it is recommended that the greatest focus be placed on steelhead production because*

- *Environmental conditions are better suited for steelhead and*
- *Newfoundland could develop a marketing advantage with steelhead in the North American market.*

### Recommendation 5.2.1.4 Grow-out Expansion and Development

The salmonid farming industry in Bay d'Espoir is now beyond the R&D stage and needs to move forward, fine-tuning production and costs, in line with industry standard "best practices."

The expansion and growth of the salmonid sector in the Bay d'Espoir region must be led by the private sector.

*It is recommended that industry be encouraged to increase the size of their existing production units to achieve the economies of scale required for long-term viability. Based on industry trends, to maintain viability and be competitive in the future, production units will have to grow to a minimum of 500 tonnes and preferably toward 1,000 tonnes.*

In addition to expanding farm production, farms must also develop cost reduction programs through improvements in farm management practices and the development of best practices and through the introduction of new technology. Improved feed management and control practices will be critical to achieving cost reductions. The most efficient way to reduce costs will be found in achieving optimal FCRs and reducing mortalities. Feed management and fish health programs will be required to optimize these parameters.

*It is recommended that industry, in collaboration with the public sector, undertake a cost reduction study and implementation program.*

### Recommendation 5.2.1.5 Human Resource Development

Business management and marketing skills are generally lacking in Newfoundland's salmonid aquaculture sector. The industry must develop or recruit this expertise. There is an opportunity to develop and deliver targeted management training on an outreach-structured basis. Key areas warranting initial treatment would include cash flow management and inventory control and management. There is also a requirement to provide ongoing training and upgrading of technical and biological skills in the field or on an outreach basis.

The capabilities exist to develop and deliver business and technical skills training programs on an outreach basis. Customized programs could be developed and delivered by a combination of NAIA, the Marine Institute, HRDC, the Department of Fisheries and Aquaculture, Memorial University, and others.

*It is recommended that training initiatives be*

- *Targeted to specific requirements,*
- *Modular in design,*
- *Delivered in the field and*
- *Potentially employing distance learning techniques and technology.*

*Support should also be provided for the mentoring and training of key personnel in farm* *management techniques on established commercial salmonid farms in other jurisdictions. This program could potentially be undertaken in concert with a strategic partner.*

### Recommendation 5.2.1.6 Hatchery/Nursery and Processing Capacity

The potential growth of the Newfoundland salmonid sector will be constrained by existing hatchery/nursery capacity. In the past, the industry has depended on the SCB hatchery as its source of supply. Recently, SCB reconfigured its hatchery production strategy in order to produce a smaller number of healthier, larger smolt and fingerlings. As a result, the Newfoundland industry's demand for seedstock is no longer being met within Newfoundland, and the industry has had to look outside the province for the purchase of seedstock.

Additional hatchery/nursery capacity for the industry will be required for existing and future projected production. Alternative ways to add hatchery/nursery production include the following:

- the construction of a new hatchery or hatcheries in Bay d'Espoir or elsewhere on the island;
- the retrofit and use of existing hatchery capacity for salmon or steelhead;
- the completion of the development of lake-side capacity at Jeddore Lake;
- the addition of lake nursery capacity in the Bay d'Espoir region (possibly using bag technology); and
- the continued purchase of smolt/fingerlings from outside the province.

Capital cost estimates for undertaking each of these initiatives range from $0.75 to $2 million.

*It is recommended that the addition of hatchery capacity be led by the private-sector, and decisions on form and location should be based on their business criteria. In order for any hatchery to be successful and assist in cost reduction, new or expanded hatchery production must produce a competitive, lowest-cost, quality smolt and/or fingerling.*

A similar approach should be taken toward the development of processing capacity, which can be supplied through the modification and expansion of existing capacity or through a new facility built by the private sector.

*It is recommended that the development of a new processing facility with value-added and freezing capabilities for the production of products for the United States and Japanese markets also be funded primarily by the private sector.*

### Recommendation 5.2.1.7 Addressing Regulatory Issues

On the regulatory front, for the long-term viability of the industry, work must continue to ensure that the industry has access to the best in commercial stocks. The stock chosen has a major impact on growth, survival and viability.

In order to achieve cost reduction and attract needed investment, industry must have reliable and consistent access to the best performing stocks. Historically, the constraints imposed which limited the acquisition of the best stock have significantly contributed to poor performance, disease incidence and reduced profitability. Industry has worked to address environmental concerns and requires a firm government commitment to the acquisition of the best stock.

*It is recommended that continued efforts to build upon new stock acquisition approvals on the political/lobby front continue to ensure future and expanded stock access. This is not a one-shot deal and will require significant efforts by NAIA, DFA, DFO and the industry into the future.*

### 5.2.2 Mussels

The mussel aquaculture industry is driven by volumes. The relatively low product value, combined with tight operating margins and a product price which has been stable for many years (but declining in real terms), indicates that economies of scale are critical to success in this industry. Prince Edward Island has been successful in developing a high-volume mussel culture industry where economies of scale in growout and processing have resulted in a long-term viability and profitability, which is in some cases now being passed on to a second generation of farmers.

Newfoundland has an opportunity to develop a long-term viable industry, by building on its considerable strengths: a marine environment highly suited to mussel culture; a potential for expansion which is much greater than that of the other Atlantic provinces; a supportive public sector; and finally, but most importantly, a core group of full-time growers and processors who are increasing their production volumes to take advantages of economies of scale and diversifying into new product opportunities.

The North American market for mussels has grown from under 11,000 tonnes in 1993 to 22,000 tonnes in 1997. Newfoundland is currently a small player in this market, with production of less than 1,000 tonnes in 1998 and a projected 1,600 tonnes in 1999. Growth of the Newfoundland mussel industry to 5,000 tonnes by 2003, combined with expected flat production in the other Atlantic provinces, will position the Newfoundland industry as a much more significant player in the market.

Growth to the 5,000 tonne level and beyond will require a concerted effort by private and public stakeholders and should be based on better utilisation of existing lease space under license (currently estimated at only 30% utilisation) and processing capacity, rather than the expansion of licenses and new entrants. An estimate of the costs required are outlined in Table 5.2. A core group of 10 to15 growers who have been producing the vast majority of mussels are demonstrating their commitment to the industry as full-time participants and are planning to expand production to economic scales of 500,000 to 2,000,000 pounds. The primary constraint facing these farmers is access to the equity capital required to lever available public funds for expansion.

**Table 5.2: Mussels Production Goal**

| Production Target | Capital Investment Required | | Incremental Employment* |
|---|---|---|---|
| 5,000 T | Processing Capacity | $2,000,000 | +20-40 |
| | Ongrowing Capacity | $10,000,000 | +40-60 |
| | Total Required | $12,000,000 | +90-150 |

* Incremental employment impacts are dampened by the required focus on increased efficiency and cost reduction. Total employment impacts include a 1.5 multiplier for spinoff benefits in service and support industries.

The following paragraphs outline the primary strategic recommendations for moving the mussel sector forward toward the 5,000 tonne production target by the year 2003. This strategy is consistent with the primary strategic directions outlined in the 1998 Mitchell Planning Partners report, to develop alliances and consolidate the industry to economical units, and to drive costs out of the industry.

### Recommendation 5.2.2.1 Investment Prospecting and Strategic Alliances

The industry is presently undercapitalized and accumulated farm debt (debt/equity ratio) precludes many farms from obtaining additional financing under existing programs. Continued mussel sector growth is predicated upon identifying an appropriate action plan to address the financing issue.

*It is recommended that, in view of this situation, the following actions be undertaken:*

- *A targeted investment prospecting program and identification of willing partners within the industry, and*
- *Encouragement and support for the formation of strategic alliances in the areas of*
  - *Financing,*
  - *Group purchasing,*
  - *Grow-out, and*
  - *Processing and marketing.*

The preferred targets for investment prospecting should also be "strategic"; that is, they should be able to bring more than money to the table, particularly business management expertise and market access.

Strategic alliances within the mussel sector offer a practical approach to resolving some of the development problems currently experienced. Cooperative agreements, on marketing for example, can reduce marketing expenses, transportation costs and create a pooling of product volumes for effective market penetration.

The continued development of alliances and consolidation within the mussel sector should be encouraged to develop a sector that has a stable group of cost efficient companies.

### Recommendation 5.2.2.2 Public Financing

The Shellfish Working Capital Fund (SWCF) has not been drawn down at the rate anticipated. Many mussel farmers have opted to apply for non repayable TJF and CJF funds which has reduced demand on the SWCF. However, the industry's accumulated debt load also precludes eligibility for SWCF and ACOA financing.

On the other hand the Mussel Incentive Program has had a positive effect on increasing seed collection and mussel production.

*It is therefore recommended that:*

- *Accumulated debt loads be reviewed and options be considered to alleviate this problem where circumstances may be warranted, and*
- *The Mussel Incentive Program be continued and increased in value.*

The financing issue is not strictly a grower problem. Processors need working capital to be able to pay farmers for their product on a timely basis and alleviate slow payments practices.

While existing debt loads are an impediment for expansion, addressing this issue must be done in combination with a comprehensive approach to the other primary issues facing the industry (comprehensive cost reduction, enhancing management capabilities, etc.).

### Recommendation 5.2.2.3 Comprehensive Cost Reduction Strategy

Industry must become more cost competitive and must place a greater focus on reducing the cost of growing, processing and marketing mussels. Over the past two years progress has been made to instill this mind set through various extension services and studies and this must be continued. Essentially each cost activity needs to be analysed to determine where cost savings can be introduced without sacrificing quality or customer service.

*It is therefore recommended that the following actions be implemented:*

- *Encourage consolidation of marketing efforts;*
- *Promote consolidation of processing efforts;*
- *Support development of economic farm production units / economies of scale;*
- *Examine ways and means to minimize product transportation costs to the processor / market, and*
- *Encourage use of Best Practices.*

A specific area of focus for cost reduction should be the minimization of transportation costs. At present most farms are having their product trucked ungraded to processing plants and are in many cases only receiving payment for less than 70% of the total weight shipped. Shipment of quantities that are smaller than truckloads is also common. The shipment of non-revenue generating product is costly and should be a primary focus of cost reduction initiatives. Seed grading and the grading of product prior to shipment, based on the development of methodologies to minimize stress on the animal, should minimize this problem.

### Recommendation 5.2.2.4 Industry Expansion - Development of Economies of Scale

If industry is to become more competitive, farms must take advantage of economies of scale through increased production. Recognizing that the individual cost structure of farms varies, it is industry's view that production should be in the range of 400,000 to 600,000 pounds or more to develop the scale economies required for long-term viability. Similarly the processing sector is operating well below existing plant capacities, and to reach economies of scale will generally need to attain annual production of 2 million pounds or more.

*It is recommended that:*

- *Policy development strategy focus upon maximizing the utilization of existing tenures, currently estimated at less than 30% usage;*
- *Support be provided for the expansion of operations to take advantage of economies of scale, subject to strong private sector investment and demonstrated strength in the technical, managerial, and marketing aspects of operations, and*

- *Consolidation of processing capacity take place to ensure that viable production units are in place, rather than a larger number of small, uneconomic operations.*

The required expansion and consolidation of production should be led by the private sector, with access to available public sector supports for capital leverage. Increasing the number of processors, for primary and secondary processing, is not required for the near term. The processing sector is concentrated on the Northeast Coast. With the expansion of industry production on the South Coast, the private sector development of processing capacity may be warranted in the future, that is, when production from the region reaches a level to support viable processing operations (over 2 million pounds per plant).

### Recommendation 5.2.2.5 Extension Services

Funding is required to continue and expand where necessary the excellent extension services program being provided to industry by NAIA and the Marine Institute of Memorial University.

*It is recommended that support be provided for extension services in the following areas:*
- *Mussel health monitoring;*
- *Seed collection and the management of secondary set;*
- *Farm production capacity;*
- *Technology transfer initiatives, and*
- *Farm management extension support.*

*It is recommended that DFA re-evaluate its role with a view to providing greater extension services where needed. Individuals identified for extension service delivery must not be responsible for industry regulation.*

### Recommendation 5.2.2.6 Focus on Quality

Developing and maintaining the highest standards of product quality must be a primary goal of the Newfoundland mussel and other aquaculture sectors. Premium quality is required to develop a preferred place in the market and to obtain maximum returns from the resource. For the mussel sector, quality manifests itself in a product of consistent size and colour with a good meat yield, no broken shells and excellent handling and packaging practices to ensure the freshest and most visually appealing products are offered for the fresh market and the value added segment.

*It is recommended that a mussel quality assurance program be implemented and that continued financial support be provided for upgrades in technology and husbandry practices both on the farm and in processing for quality enhancement initiatives. This program should consider the following initiatives:*
- *Improvements in seed grading practices and the control of socking densities to ensure optimal sizing and sock yield;*
- *Expansion of product holding system capacities to maintain product quality prior to processing and transport to market;*
- *Provision of adequate ice making equipment and ice usage to maintain product freshness, and*

- *Education of farm and plant workers on appropriate quality assurance practices.*

### Recommendation 5.2.2.7 Market & Product Development

Market and product development should be a sector priority in view of the plans to increase production and to diversify into secondary products. Market intelligence and opportunities in fresh and value added products must be pursued for both the North American and potential European markets.

*It is recommended that*
- *DFA increase its market intelligence gathering and dissemination to the industry;*
- *Strategic marketing alliances be supported, and*
- *Support be provided for product and packaging development initiatives.*

### Recommendation 5.2.2.8 Human Resource Development

Skills upgrading is essential to the successful implementation of many recommendations in this report.

**Strengthening Industry Management/Leadership**
*It is recommended that support be provided for the following:*
- *Upgrading Business Management Skills in*
  - *Cash flow management,*
  - *Inventory management,*
  - *Record keeping, and*
  - *Business planning.*
- *Development of strategic alliances that provide strong management support.*

**Strengthening Technical Skills and Competencies**
*It is recommended that skills upgrading be supported in the areas of:*
- *Basic husbandry and*
- *Quality control.*

It is recommended that support for skills upgrading through targeted workshops, industry extension and outreach programs, the recruitment of people with the skill sets that are currently lacking, and mentoring be undertaken as an industry-wide initiative. Skills upgrading is not a one-shot initiative but must consist of longer term program initiatives, that is., a structured continuous improvement program over 2 years.

### Recommendation 5.2.2.9 Addressing Regulatory Issues

The NAIA has taken a lead role in addressing regulatory issues for their members. This should continue through efforts to develop a cooperative public/private approach to fair and equitable regulation and recognition of the aquaculture sector as an important user of marine resources.

*It is recommended that NAIA focus on the following issues for the mussel sector:*
- *Ensuring and improving provision of Environment Canada's water quality testing services, and*

- *Working in consultation with DFA/DFO/Coast Guard in developing a mutually acceptable regulatory policy framework for shellfish aquaculture.*

## 5.3 DEVELOPMENTAL SPECIES STRATEGY

The species which have been identified as being in the developmental or pre-commercial stage of development include Atlantic cod, giant scallops, Arctic charr, American eels, yellowtail flounder and sea urchins. The evaluation of these species, their developmental background in Newfoundland, their current stage of development and the obstacles facing development indicate that a majority of these species should be considered as low priority for commercial development. The priority status and strategic recommendations for each species are outlined in the following pages.

### 5.3.1 Atlantic Cod

Cod aquaculture development in Newfoundland takes two forms: seasonal growout of wild cod and full-cycle culture of hatchery reared cod. Seasonal growout offers an immediate commercial opportunity while full-cycle culture requires further research and development and is a longer term development.

**Seasonal Growout**
During the past three years, seasonal growout was conducted on a limited basis to determine and demonstrate its commercial potential. Each year, live fish caught in conventional cod traps were transferred to licensed sites for four to six months of growout. This initiative, which was supported by ACERA, examined growth and quality of, and market response to, farmed cod; it also included a study of the economic potential of small scale, low-tech, fisher-operated cod farms; it transferred information and technology, and it identified key issues for future cod growout initiatives.

The results of the initiative are viewed as being very encouraging. The expansion of growout operations around the province could have quite significant potential for employment growth and economic impact. There are, however, constraints that should be addressed in further exploring the very promising potential of cod growout. Access to cod from the commercial trap fishery is unreliable. Fishers need to be encouraged to transfer their quotas to seasonal growout. Access to cod growout licenses is restricted to licensed cod trap fishers. The timing of management plans and quota access can impact on cod availability for growout operations. The cost of feed to growout operations has increased over the three years of the demonstration project, driven by greater utilization of the capelin and other species used in the cod diet, and by greater demand for freezing and cold storage capacity as a result of the greatly expanded shrimp and crab fisheries.

**Full-cycle Culture**
Cod aquaculture has not yet developed to a commercial scale worldwide. Declining wild fishery stocks have increased interest in cod aquaculture in Norway, the United Kingdom and in Atlantic Canada. Hatchery production in Norway for 1999 was approximately 200,000 juveniles, although demand was estimated at one million. Ongoing production at three small marine farms was only about 100 tonnes. Recent intelligence indicates that more marine farms are preparing to establish operation in Norway this year and that demand will exist for as much as 1.5 to 2.0 million juveniles.

Considerable historical success has been achieved with hatchery production of cod in Newfoundland. Newfoundland's position at the leading edge of cod aquaculture is acknowledged internationally. This province's participation has been sought and will be provided in the European Union Cod

Aquaculture Commercialization Research Project. In Newfoundland 50,000 cod juveniles were produced in 1999, and increased juvenile production is anticipated in 2000. A commercial scale cod hatchery is proposed and several companies and groups have demonstrated interest in marine growout, subject to availability of juveniles.

The proposed initiative to develop a commercial cod hatchery and consideration of establishing a cod nursery or intermediate overwintering operation could also broaden the options for cod growout.

It would be speculative to project minimum operating-scale capital and operating costs for full-cycle marine cod farming operations since no fully commercial production is currently undertaken. Preliminary examination of economics and scale associated with seasonal cod growout, through the ACERA project, suggest that an operation as small as 20 tonnes can be viable.

The following paragraphs outline strategic recommendations for seasonal growout and full-cycle cod culture. *Despite the acknowledgment that cod aquaculture is not yet commercial, it is recommended as a medium- to high-priority for commercial development, in the context of the developmental categorization outlined in this document.* This recommendation is based upon several factors that suggest cod is the strongest candidate for commercialization of all those species in Newfoundland that are not yet considered commercial. The factors include the following:

- Conducive marine environment,
- Suitability of biophysical characteristics,
- Strong established markets,
- Strong technical capabilities,
- Established trained human resource in cod growout,
- Established capabilities in cod processing, marketing and distribution,
- The degree of success achieved in hatchery production of cod and in the seasonal growout of cod, and
- The potential significant employment and economic impacts of both full-cycle cod aquaculture and seasonal growout or ranching.

Complimentary development strategies are recommended for both aspects of cod culture, to take advantage of the strengths each possess toward the development of a significant scale cod aquaculture industry in the province.

### Seasonal Growout Strategies

### Recommendation 5.3.1.1 Cost Reduction

Cost reduction strategies for seasonal growout and marketing are required to improve the bottom line of farmers.

*It is recommended that the following actions be implemented:*

- *Encouragement of consolidation and pooling of quotas to improve economies of scale;*
- *Encouragement of continued collaboration on marketing and processing, and expanded collaboration in purchasing;*

- *Promotion of best husbandry and health practices to reduce food conversion ratios, develop standard feed management strategies and minimize disease risk, and*
- *Promote Best Business practices.*

### Recommendation 5.3.1.2 Market Development

The development and maintenance of up-to-date market intelligence will be critical to understanding and exploiting product and market opportunities for farmed cod. Some key issues for both seasonal growout and full-cycle culture include the following:

- Exploring product differentiation of farmed cod from wild cod
- Exploring market opportunities for live cod
- Developing markets for cod by-products, for example, roe, milt, livers, heads; and
- Developing markets and marketing strategies for farmed cod that encompass the issues above and address the short time frame within which fresh product sales from the seasonal growout operations will take place.

*It is recommended that*

- *DFA increase its market intelligence gathering and dissemination to the industry. DFA currently gathers market intelligence for FANL/FFAW negotiations and this could be expanded to include more information on fresh product markets, and*
- *Strategic marketing alliances should be supported.*

### Recommendation 5.3.1.3 Growout Expansion and Development

While cod aquaculture is a recent development in Newfoundland, the techniques and husbandry for marine cage aquaculture worldwide are well documented.

*It is recommended that*

- *The cod sector transfer relevant techniques and technologies from the salmonid sector, and*
- *The development history of salmonid aquaculture be analyzed to provide lessons learned for cod development, for example, the growth of the industry from small production units to large production units.*

Action should be taken to enhance the expansion of seasonal growout.

*It is recommended that*

- *Continued public sector support be provided to further the delineation and demonstration of the economics and viability of seasonal cod growout;*
- *Cod trap fishers be encouraged to use or transfer their quotas to seasonal growout operations;*
- *Fishers be encouraged to pool their quotas for the development of larger, more cost efficient farms;*

- *The impact of the timing of DFO management plans and quota allocations on opportunities for seasonal growout be considered and steps be taken to ensure timely access is achieved, and*
- *Feed options, costs and efficiencies be examined.*

### Recommendation 5.3.1.4 Quality

Cases of poor texture have been reported for farmed cod. Indications are that this potential problem is related to the timing and impact of *rigor* on processing and may also be related to feed issues and feeding strategies prior to harvest.

*It is recommended that*

- *Further research be undertaken to develop a standard protocol for farmed cod feeding, harvesting and processing and that this protocol be disseminated to farmers and processors.*

### Recommendation 5.3.1.5 Human Resource Development

Skills upgrading among industry participants is a common theme across all species. Upgrading of management and technical skills is required for the development of a long-term viable seasonal growout industry.

**Strengthening Industry Management/Leadership**

*It is recommended that support be provided for the following:*

- *Upgrading Business Management Skills:*
    - *Cash flow management;*
    - *Inventory management;*
    - *Record keeping, and*
    - *Business planning.*
- *Development of strategic alliances bringing strong management support.*

**Strengthening Technical Skills and Competencies**

*It is recommended that skills upgrading be supported in the areas of*

- *Basic husbandry, and*
- *Quality control.*

### Recommendation 5.3.1.6 Addressing Regulatory Issues

The provincial Department of Fisheries and Aquaculture regulates the export of unprocessed or partially processed fish in order to maximize employment and economic benefits from the exploitation of our marine resources. The Department has been supportive of exporting farmed cod in HOG form through temporary exemptions to satisfy market demand. There is also potential to establish markets for live cod in the ethnic communities of certain large North American cities.

*It is recommended that industry work closely with the Department of Fisheries and Aquaculture to develop a more permanent arrangement/policy on the export of head-on gutted and live cod.*

The application of NWPA regulations to the cod farming industry must also be addressed.

*It is recommended that the industry work closely with DFA/DFO/Coast Guard on policy framework development for cod farming.*

### Full-Cycle Culture Strategies

Most of the recommendations outlined for seasonal growout are also applicable to full-cycle culture. The development of full-cycle culture will also require a focus on market and human resource development, the production of top quality product and addressing regulatory issues. Hatchery and farm development will also require a focus on economies of scale and cost control. The following paragraphs outline recommendations that are focused on full-cycle culture.

### Recommendation 5.3.1.7 Hatchery Development

Hatchery production of cod has been accomplished in Newfoundland (at Sea Forest Plantation's Placentia Bay hatchery; Newfoundland Aqua Ventures' production at the Ocean Sciences Centre, and Neilsen's facility at Dildo in the late 1890s). With the loss of the Placentia hatchery to fire, there is no commercial cod hatchery in Newfoundland at present. At least one private firm has indicated intentions to develop a commercial cod hatchery. Such a development is necessary to advance the commercialization of cod aquaculture in Newfoundland.

*It is recommended that*

- *Any public sector investment in the establishment of full-cycle cod aquaculture be private-sector driven, and predicated upon evidence of competent technical and management capabilities and strong financial commitment, and*
- *Public sector support be provided to facilitate establishment of a commercial cod hatchery, only in the event that the above conditions are met.*

### Recommendation 5.3.1.8 Nursery/Growout Development

Two Zonal Boards have indicated their interest in pursuing cod nursery / growout operations, subject to the availability of cod fry. Although it would probably be 2002 or 2003 before nursery product could be developed (subject in the first instance to the development of a cod hatchery), the potential availability of juvenile cod brought through one marine winter may present an opportunity to explore additional seasonal growout strategies and options.

Similarly, in the event that a cod hatchery is developed and cod fry become available, it is conceivable that cod growout utilizing hatchery-produced fry would be possible in the latter stages of the three-year planning horizon addressed in this strategy.

*It is recommended that consideration of provision of any public financial support to cod nursery and growout operations be predicated on evidence of competent management, technical expertise and private sector financing and commitment.*

### Recommendation 5.3.1.9 Research and Development

The new Aquaculture Research Facility established at the Ocean Sciences Centre was financed with ACERA support to promote and facilitate commercialization of aquaculture in Newfoundland.

*It is recommended that the focus and activities of the Aquaculture Research Facility reflect the priority species for commercialization. In the instance of cod, some of the research issues to address include the following:*

- *Photoperiod manipulation of broodstock;*
- *Control of cannibalism in the early juvenile stages, and*
- *Control of early maturation of males.*

Newfoundland's participation in "CodPro", a collaborative EU cod research and development initiative, may produce relevant intelligence and outcomes on these outstanding cod R&D issues for Newfoundland.

## 5.3.2 Giant Scallops

The giant scallop sector in Newfoundland has received millions of dollars in public and private sector investment over the past decade or more. This investment has not resulted in the development of a commercial giant scallop sector in the province.

Obstacles have been faced in scaling up hatchery production from pilot to commercial scale. These obstacles remain and production from the scallop hatchery has been sporadic and disappointing. At present production levels, the hatchery is not an economically viable entity. The ability to scale up production to economic levels in a short time frame is not assured.

On the growout side, the industry has been led by a small number of highly dedicated farmers. These farmers have not been successful in establishing commercial scallop farms and have pulled back from making new investments in the industry. Economic studies on scallop farming have indicated the potential to achieve marginal profitability but the activity does not promise to provide a return in line with the high level of risk.

Although commercial aquaculture of other scallop species has expanded to a worldwide total of over 1.3 million tonnes, the successful commercial development of giant scallop culture in Canada has not been achieved. The total production of giant scallops in Canada has only reached volumes of around 20 tonnes.

Given the lack of current private sector support, the inability of the hatchery to reach commercial production levels, the questionable economics of hatchery and farm production, and questionable market prospects for anything other than scallop meats, scallops should not be considered a priority for commercial development in Newfoundland.

**Recommendation 5.3.2.1** *Giant scallop aquaculture should not be considered a priority for commercial development and should not be provided with additional financial support.*

**Recommendation 5.3.2.2** *Future development of scallop aquaculture in Newfoundland should only be supported as private sector led initiatives based on sound business plans (as previously defined) and only if the basic obstacles to development (such as economic viability, secure seed supply, etc.) have been overcome.*

### 5.3.3 Arctic charr

Arctic charr is another species which has received substantial financial support but has not achieved commercial development or demonstrated the potential for commercial viability. On a world-wide basis, charr has not been proven to be commercially viable, largely due to broodstock development and growout problems.

In Newfoundland, the majority of charr research and development has taken place on the Great Northern Peninsula. Research has shown that cage culture in the region is not viable due to disease problems and slow growth rates. An independent evaluation of the recently completed land-based hatchery and growout facility has shown that this facility is not suitable for commercial-scale charr development without major upgrades.

**Recommendation 5.3.3.1** *Arctic charr aquaculture should not be considered a priority for commercial development and should not be provided with additional financial support.*

**Recommendation 5.3.3.2** *Future development of Arctic charr aquaculture in Newfoundland should only be supported as private sector led initiatives based on sound business plans (as previously defined) and only if the basic obstacles to development (availability of a proven broodstock, improved growth rates, secured niche market positioning and economic viability) have been overcome.*

### 5.3.4 American eels

Eels are a proven commercial aquaculture species. The technology for commercial eel production in cold water climates has been developed and proven and is available on a "turn-key" basis. In Newfoundland, pilot-scale efforts have demonstrated the ability to successfully grow American eels. Development of this species as a commercial venture will be primarily dependent upon a proven and secure access to elvers and the strength of the private sector proponent.

**Recommendation 5.3.4.1**

With the completion of research to demonstrate the performance characteristics of American eels compared with other eel species currently in commercial production, American eels may offer an opportunity for a limited number of entrepreneurs with the financial, biological/technical, and market resources required to develop turn-key systems from Northern Europe. The development of this species in the province may also be limited by the availability of wild elvers.

*It is recommended that support for development be subject to the following caveats:*

- *Development must be led by the private sector. The private sector must demonstrate strength in all required areas:*
  - *Biological/technical - The proponent must have access to turn-key development using the latest technology; and access to technical and biological expertise to run the recirculation facility for eel production. The performance ability of American eels must be demonstrated.*
  - *Financial/Economic - Adequate private sector capital must be available to support the fixed and working capital needs of the project and to lever public investment. The project must be developed to an economic scale, estimated at 200 tonnes per annum.*
  - *Managerial - The required managerial expertise must be available to run a large-scale commercial aquaculture development.*
  - *Marketing - Expertise in the eel market, market intelligence and market access must be demonstrated.*
  - *Proponent must demonstrate ability to access sufficient quantities of elvers for production.*

### 5.3.5 Yellowtail flounder

Yellowtail flounder has been the subject of research and pilot-scale trials at Memorial University's Ocean Sciences Centre for the past five years. This species is not commercially cultured anywhere in the world. While trials have demonstrated the ability to successfully produce large numbers of juveniles, they have also indicated a relatively slow growth rate which would require at least three years before reaching a market size of around one kilogram. Based on the requirement for development under capital intensive land-based systems, an economic analysis of yellowtail culture has indicated that viability can only be achieved through growth to market size in less than two years and sale to market at a premium price over the wild product. As such, yellowtail flounder culture should be considered uneconomic at the present time.

**Recommendation 5.3.5.1**

*Yellowtail flounder aquaculture should not be considered a priority for commercial development and should not be provided with additional financial support for commercial purposes.*

### 5.3.6 Sea Urchins

Sea urchins have been the focus of studies primarily directed at enhancing the roe yield and quality of the wild animals. Very preliminary research on full-scale urchin aquaculture has also been initiated. Urchins have not been developed as a commercial aquaculture species.

Trials have demonstrated the ability to substantially increase roe yield and current efforts are focused on developing an artificial diet that can rapidly improve roe yield while also providing good quality roe. Advances are being made in this area but an optimal commercial diet has yet to be developed.

Technology options for roe enhancement include land-based and sea bottom culture. To date, the economics of sea urchin roe enhancement appear to favour sea bottom culture, although commercial viability has not been proven for either method. Further commercial development will have to be entrepreneur-driven, and the potential will be highly site specific.

**Recommendation 5.3.6.1**

*Sea urchin aquaculture should not be considered a priority for commercial development at this time. The potential may exist for future development based on addressing outstanding issues.*

*Support for sea urchin aquaculture should focus on roe enhancement rather than full-cycle culture. Roe enhancement, especially through bottom culture, appears to offer favorable potential and should be considered for public support on a case-by-case basis.*

**Recommendation 5.3.6.2**

*Support for sea urchin aquaculture research and development should be focused on addressing outstanding issues with respect to feed development and economic potential. Private sector-led and collaborative, coordinated initiatives among current players should be given priority.*

## 5.4 RESEARCH SPECIES STRATEGY

Species identified as being in the research stage in Newfoundland include Atlantic halibut, wolffish, Witch flounder, soft-shell clams and seaweed. None of these species has reached the stage of development in the province to warrant consideration as a priority for commercial development. The species analyses and identification of issues have shown that significant roadblocks exist which must be removed before these species can be given commercial consideration and considered as priorities for development. It is likely that a number of these species will never develop as commercial aquaculture species in the province.

Table 5.3 outlines the major stumbling blocks for each species that must be overcome before these species can be given consideration for inclusion as commercial development priorities.

**Table 5.3: Research Species - Roadblocks to Development**

| Species | Roadblocks |
|---|---|
| Atlantic halibut | • Hatchery production of juveniles has not been successful to date in Newfoundland, with low numbers produced in each of the last three years. Improved juvenile production is being achieved elsewhere (Iceland, Scotland, Norway) but the optimal technology for juvenile production has not been determined.<br>• Development of halibut culture in Newfoundland will require multi-million dollar land-based production facilities. It will also require significant private sector commitment and investment.<br>• The economic viability of hatchery production and growout has not been proven.<br>• With the current market supply of wild Atlantic halibut at low levels (4,000 t-5,000 t) the introduction of relatively small quantities of cultured halibut (1,000 t +) has the potential to cause significant market disruption and downward price pressure. |
| Wolffish | • The market price for wolffish in North America is very low. Major market development efforts costing millions of dollars would be required to reposition wolffish in the marketplace.<br>• Based on low prices and the potential requirement for expensive land-based culture systems, wolffish production is not economically viable at present.<br>• Industrial partners (with the deep pockets required) have not been identified for wolffish culture in Newfoundland. |
| Witch flounder | • This species demonstrates extremely slow growth rates.<br>• It is not considered economically viable, and there is no potential for viability given growth rates.<br>• It is a difficult species to work with in terms of broodstock and egg collection. |
| Soft shell clams | • Very little work has been done on the potential for species aquaculture in Newfoundland - most of the work to date has been in the area of wild resource assessment and the potential for relaying to improve growth.<br>• Newfoundland's cold waters lead to slower growth.<br>• Economics are highly questionable due to slow growth, apparent low wild spatfall, potential requirement for hatchery seed, and the requirement for depuration in identified areas. |
| Seaweed | • This is in a very early stage of research, and potential for its development is unknown. |

The recommended overall strategy for these species is simple: *Do not include these species in the priority list for commercial development at this time. Future reevaluation of these species should be based on a positive reassessment of their evaluation framework and proof that the roadblocks to commercial development have been overcome. Future R&D work, if warranted, should be based on private sector initiatives with the Canadian Centre for Fisheries Innovation as the primary support agency.* Recommendations for each species are outlined in Table 5.4.

**Table 5.4 Research Species - Strategic Recommendations**

| Species | Strategic Recommendations |
|---|---|
| Atlantic halibut | • Future developments must be private sector-driven, as the financing required for development of halibut culture will be substantial. The private sector should consider strategic alliances with successful producers of juveniles.<br>• Given that much is still unknown about optimal hatchery and growout technologies and the potential economic viability of halibut culture, a "wait and see" approach is recommended.<br>• Future hatchery research in Newfoundland should focus on controlled experiments for improving hygiene and food quality, rather than on costly pilot-scale production. |
| Wolffish | • Limited research is recommended, on the North American market, in collaboration with AkvaPlan Niva of Norway. Further technical/biological investigations are not recommended. |
| Witch flounder | • This species is not recommended for further research, because of the slow growth rates; any research on this fish would be a purely academic undertaking. |
| Soft shell clams | • This is not a priority for future research. Poor growth rates and apparently poor recruitment limit future potential. |
| Seaweed | • The potential is unknown. It is recommended that limited, controlled and staged trials be undertaken to determine growth potential in conjunction with available expertise. |

## 5.5 EVALUATION MECHANISMS

The species evaluations presented in this report are based on currently available information. It is possible that changing circumstances, for example, changing market outlooks and biological breakthroughs, may in the future warrant the reevaluation of species potential and priorities. It is recommended that the following approach be taken to future species reevaluations:

- Reevaluation should be undertaken against the current (2000) evaluation framework provided for each species. The following questions should be posed:

  What has changed to warrant reevaluation? Have circumstances changed for any of the primary issues identified in the framework that would warrant either a positive or negative reevaluation of potential and priority?

Wolffish, for example, would warrant reassessment if there was a significant change in market circumstances and private sector support. Similarly, cod should be reassessed if there is a rebound in the wild fishery, an inability to differentiate cultured cod in the market, or a significant reduction in prices, all of which could negatively affect potential.

In addition to species evaluations, for each project that is proposed an individual evaluation must take place by potential funding/support agencies. As stressed throughout this document this evaluation should be based on the assessment of an entrepreneur's ability and strength in all major areas: managerial, technical/biological, marketing, processing, and financial. For areas of potential weakness proponents must identify sources of support and/or strategic alliances.

## 5.6 SUMMARY - STRATEGIC PRIORITIES

The strategic priorities for the Newfoundland aquaculture industry and specific strategic recommendations for the primary species under consideration; steelhead trout, Blue mussels, Atlantic salmon and Atlantic cod, are summarized in Table 5.5. Strategic recommendations are grouped under 11 primary headings.